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Applicability of Interceptive Orthodontics in the Community

KAZEM AL NIMRI, B.D.S.

ANDREW RICHARDSON, M. SC. , F.F.D., D. ORTH.

Orthodontic Division, School of Clinical Dentistry, Royal Victoria Hospital, Belfast BT12 6BP, Northern Ireland

Abstract. *The term interceptive orthodontics used in this paper is defined as the prompt treatment of unfavourable features of a developing occlusion categorized as local factors, crowding and displacements of the mandible in closing from the rest position. The aims of the study were to determine the best age or ages for interceptive orthodontics, to establish diagnostic cut-off points for self-correcting features of the developing occlusion which can be quantified, to investigate the reproducibility of treatment decisions and to make an initial estimate of the percentage of children suitable for interception. Based on material in the Belfast Growth Study, maximum or minimum measurements associated with spontaneous correc - tion of quantifiable features were determined and incorporated into a disposable plastic gauge. Using the gauge, the available records of 278 Growth Study subjects at age 9 years and 272 at age 11 years were assessed for suitability for inter - ception. Most of the conditions for interceptive treatments were present at age 9 years, but others were not present until 11 years. The majority of treatment decisions were highly reproducible. Approximately 50 per cent of the children in the Growth Study would have benefitted from interceptive orthodontics. A follow-up community study seems justified.*

Index words: Interceptive treatment.

Introduction

Interceptive orthodontics means different things to different people. Some orthodontists apply the term to any treatment in the mixed dentition which will prevent the establishment of a malocclusion, partially or totally (Bass, 1996), others favour early appliance therapy as an optional alternative to treating malocclusions after the permanent dentition is established or as a preliminary phase of treatment (Woodside, 1996). Those who favour early treatment are guided by the principle of promoting developmental changes which are favourable and of suppressing features which are unfavourable. Richardson, (1995) has placed emphasis on minimizing unfavourable features of occlusal development where early detection and treatment may make the difference between achieving a satisfactory result by simple means as against prolonged mechanical treatment at a later stage. Interception in this sense is probably nearer the traditional definition of preventive orthodontics than most. Seen from this perspective, the indications for interceptive treatment can be reduced to local factors, crowding, and displacements of the mandible in closing from the rest position. Local factors include impacted upper first molars, retained deciduous teeth related to malposed permanent teeth and delayed eruption of permanent teeth caused by supernumerary teeth where the benefits of early treatment are well-established (Munns, 1981). The interceptive treatment of crowding includes space maintenance or space management (Proffit, 1993) and serial extraction (Kjellgren, 1947; Dewel, 1970). Displacements are taken to mean deflections of the mandible from a normal closure path, which may be associated with a unilateral cross-bite and long unworn deciduous canine teeth or lingual occlusion of erupting permanent incisors.

An example may illustrate the economic benefits of interception: impaction of the maxillary canine tooth is commonly treated by surgical exposure of the crown and bracket bonding with or without replacement of the flap, followed by orthodontic alignment with fixed appliances. The exposure is frequently carried out under general anaesthesia in theatre by an oral surgeon and the fixed appliance work is usually done by an orthodontist rather than a general practitioner, all of which is expensive. National Health Service costings do not seem to exist for this treatment, but there is no doubt that it can be reckoned in millions of pounds annually. As shown by Ericson and Kurol (1988), simple extraction of the deciduous canine between the ages of 10 and 13 years leads to spontaneous alignment in 91 per cent of cases if malposition of the permanent canine is minor and in 64 per cent if the malposition is major.

Interceptive measures may have the advantage of simplicity and economy, but they must be applied at critical stages of development. Early detection of orthodontic abnormalities and interception is presently in the hands of the general dental practitioner. Although the practitioner may be strategically placed to detect abnormalities in the patients he or she sees, the chain of referral to an orthodontist often results in patients having orthodontic consultations too late for effective interception and 39 per cent of 8-year-old and 36 per cent of 12-year-old children in the United Kingdom do not attend a practitioner regularly (O'Brien, 1993). These children have little chance of receiving interceptive treatment unless the anomaly is detected by a Community Dentist while screening for dental caries and periodontal diseases.

If interception is to play a significant part in meeting the need and demand for orthodontic treatment, screening of the child population would be essential. There might be great benefits in a screening procedure specifically and

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exclusively to identify children who would benefit from interceptive orthodontics. This would be at its best in child groups who, for one reason or another, are deprived of conventional orthodontic care and where orthodontic manpower deficiencies militate against a ready solution. Conventional screening for malocclusion would be likely to generate a demand for appliance therapy which in most areas could not be met under present circumstances.

The reported numbers of children who would benefit from interception vary widely on account of different definitions of interception, different aims and differences between the samples. Popovich and Thompson (1975) estimated that 49 per cent of their subjects would benefit from interceptive treatment while Freeman (1977), and Ackerman and Proffit (1980) concluded that 14·3 per cent of their patients could be treated by interception alone. Hiles (1985), in a British study, found that 38.6 per cent of children would benefit from interception.

The present investigation had four aims :

1. To determine the best age or ages for interception.
2. To establish diagnostic cut-off points for quantifiable features of the developing occlusion which may correct spontaneously without any treatment whatever.
3. To investigate the reproducibility of treatment decisions.
4. To investigate the percentage of children suitable for interceptive treatment.

Material and methods

The material for the investigation was the records of children enrolled in the Belfast Growth Study (Adams, 1971). The Growth Study sample was derived from all children in Belfast aged between 4·5 and 5·5 years who had three or less than three carious cavities which could be restored and where parental consent to inclusion in the Growth Study was given.

The resulting sample of 304 children had cephalometric radiographs taken each year and impressions at 6-monthly intervals up to the age of 15 years. As far as the authors are aware, none of the subjects included in the present study received any orthodontic treatment.

The best age or ages for interception

The recommendations for interception in the literature were listed (Table 1) and the Growth Study material was scanned for presence of the appropriate diagnostic features. In a substantial number of subjects, some of the conditions for interception were not present before 9 years because the permanent lateral incisors had not erupted. Other indications for interception, such as extraction of deciduous canines to assist eruption of permanent canines which are not palpable in the buccal sulcus, were not present until 11 years on account of the palatal position of normally-developing canines before this age (Coulter and Richardson, 1997. Accordingly, the indications for interception were divided into two lists appropriate at ages 9 and 11 years, respectively (Tables 2 and 3). The lists differ in that interceptive treatment of transposition by extraction, first molar impaction, recent extraction by space maintenance and carious first permanent molar extraction are appropriate at 9 years, but too late at 11 years, whereas the detection of maxillary canines which can not be palpated in the buccal sulcus is not appropriate until 11 years. Table 4 shows the Growth Study material available at age 9 and 11 years. The subjects excluded did not have records at the ages appropriate for the present study.

TABLE 1 *Interceptive possibilities*

Diagnosis	Treatment
Absent teeth	Close or maintain space
Delayed eruption	Investigate
Erupted Supernumerary tooth	Extract
Retained deciduous teeth	Extract
Unilateral retained deciduous canine	Extract
Malformed teeth	Mask, extract, split
Transposition	Extract
First molar impaction	Extract E, distalize, observe
Recent extraction	Maintain space
Carious permanent first molar	Extract
Crowding	Distalize molar, extract incisor, premolar, first molar, serial extraction
Ectopic upper canine	Extract deciduous canines
Spacing	Remove pathology
Anterior open bite	Advise, deterrent appliance
Incisor in lingual occlusion	Procline
Increased overjet	Reduce overjet
Displacement	Grind or extract deciduous canine expand

TABLE 2 *Interceptive possibilities at age 9 years*

Diagnosis	Treatment
Absent teeth	Close or maintain space
Delayed eruption	Investigate
Erupted supernumerary tooth	Extract
Retained deciduous teeth	Extract
Unilateral retained deciduous canine	Extract
Malformed teeth	Mask, extract, split
Transposition	Extract
First molar impaction	Extract E, distalize , observe
Recent extraction	Maintain space
Carious permanent first molar	Extract
Crowding	Distalize molar, extract incisor, premolar, first molar, serial extraction
Spacing	Remove pathology
Anterior open bite	Advise, deterrent appliance
Incisor in lingual occlusion	Procline
Increased overjet	Reduce overjet
Displacement	Grind or extract deciduous canines, expand

Diagnostic cut-off points

The next step was to quantify the following:

1. The smallest distance between the distal surface of the permanent lateral incisor and mesial surface of the first permanent molar at age 9 years, which was compatible with good alignment of the canine and premolar teeth after they had erupted.
2 The largest diastema between the upper central incisors at age 9 years which closed spontaneously.

TABLE 3 *Interceptive possibilities at age 11 years*

Diagnosis	Treatment
Absent teeth	Close or maintain space
Delayed eruption	Investigate
Erupted supernumerary tooth	Extract
Retained deciduous teeth	Extract
Malformed teeth	Mask, extract, split
Carious permanent first molar	Extract
Ectopic upper canine	Extract deciduous canines
Crowding	Distalize molar, extract incisor, premolar, first molar, second molar
Spacing	Remove pathology
Incisor in lingual occlusion	Procline
Displacement	Grind, expand

TABLE 4 *Growth Study material at age 9 and 11 years*

Age	Males	Females	Total
9 years	144	134	278
11 years	139	133	272

3. The largest amount of crowding of the lower incisors at age 9 years which decrowded spontaneously.

In the case of the lateral incisor-first molar space, the Growth Study material at age 14 years was examined to identify subjects without crowding in the canine-premolar area. The casts of these subjects at age 9 years were measured using a Boley Gauge to identify the 10 subjects with the smallest lateral incisor-first molar spaces. The spaces in these 10 subjects were then measured using a travelling microscope and the smallest determined. A similar procedure was followed for the midline diastema measurement. The maximum decrowding of lower incisors was identified from travelling microscope measurement of incisor crowding on first eruption, and at the stage of canine eruption (Lundy and Richardson, 1995). These measurements, together with a 6mm indent suitable for measuring overjets, were incorporated into a disposable plastic gauge (Fig.1). The diastema measurement is at the top of the gauge, the lateral incisor-first molar measurement between the two peaks at the lower right and the six millimetre overjet measurement between the right edge of the gauge and the first of the peaks. The left end of the gauge is stepped corresponding to 0·5, 1·0, 1·5, and 2·0 mm to facilitate measurement of lower incisor crowding.

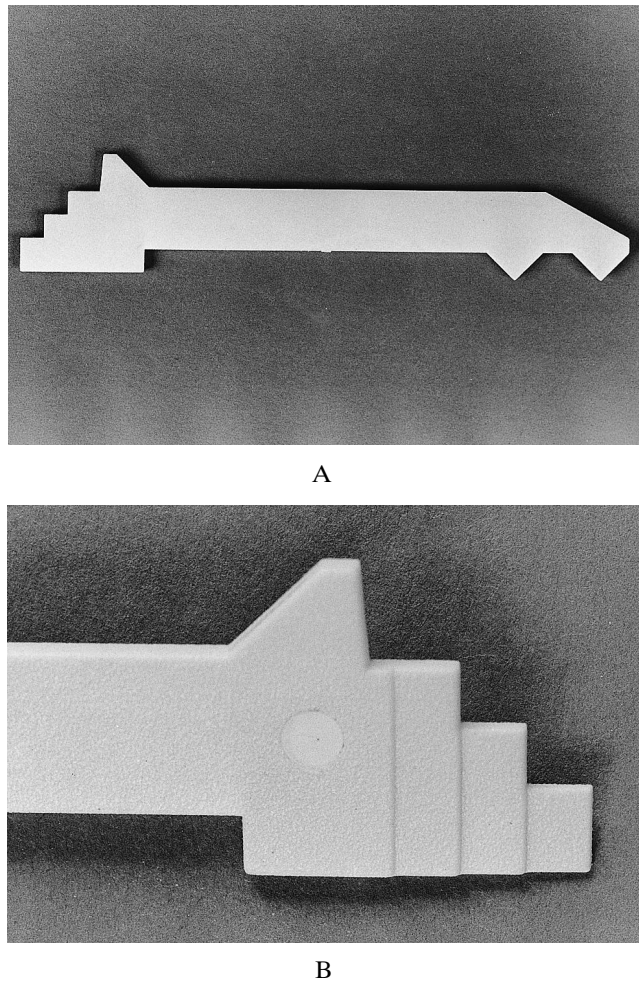

FIG. 1 The interceptive gauge. (A) The diastema measurement is at the top of the gauge, the lateral incisor-first molar measurement between the two peaks at the lower right and the 6-mm overjet measurement between the right edge of the gauge and the first of the peaks. (B) The left end of the gauge is stepped corresponding to 0·5, 1·0, 1·5, and 2·0 mm to facilitate measurement of lower incisor crowding.

The reproducibility of treatment decisions and percentage suitable for interceptive treatment

With the assistance of the gauge, all available study casts of children in the growth study at the ages of 9 and 11 years were screened for the indications for interception. Both authors examined the material independently for reproducibility testing.

Results

The smallest distance between the distal surface of the lateral incisor and mesial surface of the first permanent molar at age 9 years which was compatible with subsequent good alignment of the canine and premolars was found to be 18.75 mm in the lower arch and 18.25 mm in the upper arch. These measurements were combined into a 18.5-mm measurement in the gauge. The largest upper midline diastema at age 9 years which closed spontaneously was 2·50 mm. The maximum amount of spontaneous decrowding of incisors was found to be 3·80 mm (Lundy and Richardson, 1995). The measurement of a 6-mm overjet was included because there is evidence that overjets which exceed this figure are associated with traumatic damage to incisor teeth (Järvinen, 1978, 1979).

The results of the screening at 9 years are shown in Table 5 and at 11 years in Table 6.

For the diagnostic categories the Kappa values were much more favourable than 0·8 which indicates good agreement between observers (Landis and Koch, 1977) with the exception of recent extraction, ectopic upper canine and spacing. In the treatment categories, the reproducibility of observations was also good or substantial (above 0·6) with the exception of 'crowding/distalize

TABLE 5 *The applicability of interception at age 9 years and the reproducibility of results*

Diagnosis/treatment	Number observed examiner 1	Percentage observed examiner 1	Number observed examiner 2	Percentage observed examiner 2	Kappa value
Cases for interception	138	51%	132	49%	0·90
Absent teeth	6	2%	6	2%	1·00
Absent teeth/ close space	4	1·5%	4	1·5%	1·00
Absent teeth/ maintain space	0		0		
Delayed eruption	0		0		
Erupted supernumerary/extract	0		0		
Retained deciduous teeth	13	5%	15	6%	0·92
Unilateral retained deciduous C	42	15%	42	15%	1·00
Malformed teeth	0		0		
Malformed teeth/mask	0		0		
Malformed teeth/extract	0		0		
Malformed teeth/split	0		0		
Transposition	0		0		
Molar impaction	1	0·3%	1	0·3%	1·00
Molar impaction/extract E	1	0·3%	1	0·3%	1·00
Molar impaction/distalize	0		0		
Molar impaction/observe	0		0		
Recent extraction	18	7%	9	3%	0·42
Carious permanent first molar	12	4%	10	4%	0·91
Crowding	75	28%	70	26%	0·86
Crowding/distalize molar	7	3%	2	0·7%	0·40
Crowding/extract incisor	0		0		
Crowding/extract premolar	11	4%	15	6%	0·76
Crowding/extract first molar	4	4%	2	3%	0·66
Crowding/serial extraction	23	8%	19	7%	0·74
Spacing/remove pathology	11	4%	11	4%	0·91
Anterior open bite	7	3%	7	3%	1·00
Anterior open bite/advise	0		0		
Anterior open bite/deterrent	4	1·5%	5	2%	0·89
Incisor in lingual occlusion	15	6%	15	6%	1·00
Increased overjet	26	10%	26	10%	0·96
Displacement	11	4%	11	4%	0·91
Displacement/grind	2	0·7%	2	0·7%	1·00
Displacement/extract C	5	2%	4	1·5%	0·89
Displacement/expand	4	1·5%	5	2%	0·66

molar' at age 9 years and 'crowding/extract first molar' at age 11 years.

Overall, 50 per cent of children at both ages were suitable for some form of interception, notably treatment of unilateral retained deciduous canine, crowding, and increased overjet at age 9 years, and retained deciduous teeth and crowding at 11 years.

Discussion

Children enrolled in the growth study were representative of the child population of Belfast except that the prognosis for survival of their deciduous teeth was better than average. Children not included would probably have had an increased need for extraction of deciduous molars through caries and thus would have had a higher prevalence of secondary crowding with a greater need for extraction of premolar teeth. In this respect, the numbers benefiting from interception in this study are likely to be underestimates. On the other hand, there would probably have been a greater number of caries-susceptible children having extraction of first permanent molars which would have given space for crowded teeth.

The prevalence of caries has diminished since the material was collected (although less so in Northern Ireland than in other regions of the United Kingdom) and the results should be applied to the present population with caution.

In most respects, the casts used in this study simulated the examination of children in a community screening exercise. The material is similar in that no periapical, occlusal, or panoramic radiographs were available, and it is presumed in presenting the results that subsequent radiological findings, where necessary, were in keeping with the clinical findings.

The reproducibility of the observations by the two examiners was very high except for 'recent extraction' which is much more difficult to detect on casts than in the mouth and 'ectopic upper canine' (a canine which is not palpable buccally). In the case of the study casts, it was as much inability to perceive a canine prominence as palpation. A 'recent extraction' was scored when there was evidence of an incompletely healed socket as distinct from the case where the alveolar process was smooth and rounded. The distinction is significant in deciding whether to use a space maintainer bearing in mind that much of the total space closure occurs in the first few months after the extraction.

'Spacing/remove pathology' relates to upper midline diastemata which were greater than the largest which

TABLE 6 *The applicability of interception at age 11 years and the reproducibility of results*

Diagnosis/treatment	Number observed examiner 1	Percentage observed examiner 1	Number observed examiner 2	Percentage observed examiner 2	Kappa value
Cases for interception	141	52%	137	50%	0·90
Absent teeth	5	2%	5	2%	1·00
Absent teeth/close space	4	1·5%	4	1·5%	1·00
Absent teeth/maintain space	0		0		
Delayed eruption	0		0		
Erupted supernumerary/extract	0		0		
Retained deciduous teeth	58	21%	56	20%	0·93
Malformed teeth	1	0·3%	1	0·3%	1·00
Malformed teeth/mask	1	0·3%	1	0·3%	1·00
Malformed teeth/extract	0		0		
Malformed teeth/split	0		0		
Carious permanent first molar	19	7%	11	4%	0·72
Ectopic upper canine	19	7%	22	8%	0·55
Crowding	76	28%	70	26%	0·85
Crowding/distalize molar	0		0		
Crowding/extract incisor	1	0·3%	2	0·7%	0·67
Crowding/extract premolar	52	19%	50	18%	0·86
Crowding/extract first molar	5	2%	2	0·7%	0·57
Crowding/extract second molar	0		0		
Spacing/remove pathology	4	1·5%	2	0·7%	0·66
Incisor in lingual occlusion	19	7%	17	6%	0·94
Displacement	9	3%	8	3%	0·82
Displacement/grind	0		0		
Displacement/expand	9	3%	8	3%	0·82

closed spontaneously in the Growth Study. This might signal the presence of a cyst or supernumerary tooth and the treatment indication of 'remove pathology'. The low Kappa value in this category was accentuated by the very small numbers in the group. If one observer had scored one more and the other observer one less, there would have been perfect agreement.

Another limitation of the study casts is the probable inflation of numbers in the category of 'retained deciduous teeth' some of which may have been mobile, rendering extraction unnecessary.

The Interception Gauge proved to be very useful in categorizing quantifiable features.

The reason for choosing the largest diastema, the smallest space in the canine-premolar region and the largest amount of incisor crowding which resolved spontaneously was that using average figures would have prejudiced the findings in that half of the sample would inevitably be found to have space deficiency and the other half no space deficiency. A similar argument would apply to any other statistically-derived figure. In spite of the stringent criteria, it was interesting to find substantial numbers in need of interception.

The numbers benefiting from interception were very close to the 49 per cent found in the community study of Popovich and Thompson (1975) who defined interception as 'procedures which eliminate or reduce the severity of malocclusion'. The present findings were, however, much higher than those from the Pennsylvania studies of Freeman (1977), and Ackerman and Proffit (1980) who set the high standard of 'acceptable occlusion' as their goal in patients who attended because their parents felt they were in need of treatment. In the Pennsylvania study, appliance therapy was included in the definition of interception. The community study of Hiles (1985) in Winchester is the most comparable to the present work in that the study sample of children was British and the aims of reducing or obviating the need for mechanical treatment were similar. Hiles found that 38.6 per cent would benefit from interception, which included simple mechanical treatment.

Although the numbers suitable for interception in the present study are remarkably high and make the case for community interception, it should be stressed that no claim is made that the interceptive treatment would completely treat every malocclusion.

Conclusions

1. The most suitable ages for screening the child population for interceptive orthodontics is 9 years and 11 years.
2. The Interception Gauge is useful in categorizing children in respect of features of the dentition which are quantifiable.
3. Almost half of the subjects in the Belfast Growth Study would have derived some benefit from interceptive orthodontics.
4. The findings in this study justify a follow-up community investigation.

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