Palatally impacted canines and the modified index of orthodontic treatment need

S. T. Barlow*, M. B. Moore*, M. Sherriff**, A. J. Ireland*** and J. R. Sandy*** *Royal Devon and Exeter Hospital, Exeter, **Kings College, London Dental School and ***University of Bristol Dental School, UK

SUMMARY The aim of this study was to assess the severity of any underlying malocclusion in subjects presenting for treatment of a palatally impacted canine (PIC) using a modification of the Dental Health Component (DHC) of the Index of Treatment Need (MIOTN), which does not factor in the impacted canine. The pre-treatment study models of 54 subjects who had previously undergone surgical exposure of a PIC, followed by fixed appliance orthodontic alignment, were scored independently by two examiners on two occasions using the MIOTN system.

Unweighted kappa statistics revealed good intraoperator agreement for the two examiners and a moderate level of interexaminer agreement. Forty-six and 41 per cent of the sample still scored either an MIOTN grade 4 or 5 (i.e. a great or very great need of orthodontic treatment). However, 20 and 25 per cent of the subjects were graded with a MIOTN score of 1 or 2, indicating little or no need for treatment when the PIC was not taken into consideration. This finding emphasizes the importance of early diagnosis of an impacted canine and the need to institute interceptive measures where necessary, as up to 25 per cent of patients might otherwise require no other orthodontic treatment.

Introduction

A malocclusion is considered to be a variation from the norm rather than an acute condition (Wylie, 1947; Shaw *et al.*, 1991) and the dental, functional, and psychological benefits of orthodontic treatment to correct it are largely unknown. This in turn leads to difficulty in determining orthodontic treatment need (Shaw, 1981). It has been shown that both providers' and patients' perceptions of orthodontic treatment need are influenced by many variables (Shaw *et al.*, 1991), but the decisive factor for the patient is usually poor aesthetics (Brook and Shaw, 1989; Richmond *et al.*, 1995).

In recent years, various orthodontic indices have been developed, both as methods of determining the level of orthodontic treatment need and as indicators of the clinical outcome of orthodontic treatment. Indices designed to assess treatment need quantify various morphological features of the malocclusion and deliver a numeric value below which the severity of the malocclusion may be considered too minor to warrant treatment. Early indices assessing treatment need included the Treatment Priority Index (Grainger, 1967), the Handicapping Malocclusion Assessment Record (Salzmann, 1968), and the Occlusal Index (Summers, 1971). In the United Kingdom (UK), the Index of Orthodontic Treatment Need (IOTN; Brook and Shaw, 1989) was developed as a composite of the Standardised Continuum of Aesthetic Need (Evans and Shaw, 1987) and the Swedish Dental Health Board Index (Linder-Aronson, 1974), with the intention of identifying those individuals who would be most likely to benefit from

orthodontic treatment. It comprises two components, a Dental Health Component (DHC) and an Aesthetic Component (AC), and ranks malocclusion in terms of significance of various occlusal traits for an individual's dental health and for perceived aesthetic impairment. This index was originally validated by 74 dentists and the gradings were grouped to reflect British dental opinion. They are now recognized both nationally and internationally as an objective measure of orthodontic treatment need with a high level of reproducibility (Brook and Shaw, 1989; Burden and Holmes, 1994), reliability, including reliability over time for untreated 11- to 19-year-olds (Cooper *et al.*, 2000), and validity (Burden and Holmes, 1994; Burden *et al.*, 1994; Richmond *et al.*, 1994; Shaw *et al.*, 1995).

The incidence of impacted upper permanent canines within the general population is approximately 1.5-2 per cent (Thilander and Jakobsson, 1968) with up to 85 per cent of these being palatal impactions (Ericson and Kurol, 1987). Not uncommonly, the prescribed treatment for palatally impacted canines (PICs) is surgical exposure and orthodontic realignment. The exposure is usually carried out under general anaesthesia, as a day case admission, and the subsequent orthodontic treatment to realign the tooth often exceeds 2 years. This treatment regimen therefore incurs not inconsiderable costs to any publicly funded health service, such as the National Health Service (NHS) in the UK, and to the patient. The failure to diagnose and refer at an appropriate age a patient with one or more PIC is a recognized problem. What is interesting is that anecdotally many individuals presenting with one or more PICs often do not seem to require

orthodontic treatment for any other features of their occlusion. This perhaps may contribute to why such cases present late for orthodontic treatment, with patients frequently unaware that they have a problem. A PIC scores an IOTN DHC grade of 5, that is, great treatment need. However, if the PIC were to be excluded, would the individual still qualify for orthodontic treatment within a publicly funded system? Within the UK, only those cases with an IOTN DHC grade of 3 (and an AC of 6 and above) would qualify for treatment under the current NHS guidelines (Department of Health, 2008).

The aim of this study was therefore to use a modification of the IOTN DHC, Modified Index of Treatment Need (MIOTN), which excluded the 5i score relating to the PIC, in order to score the other features of the occlusion. This would enable the anecdotal impression to be either supported or refuted.

Materials and methods

This study was undertaken as part of a larger microcosting analysis investigating the cost of aligning a PIC using a closed surgical exposure technique and fixed appliance orthodontics. The patients had all been treated by the same orthodontic team at two district general hospitals in Devon, UK. These were the Royal Devon and Exeter Hospital (RDE) and the North Devon District Hospital (NDDH). Ethical approval was obtained from North and East Devon Research Ethics Committee (06/Q2102/83).

Sample

The sample comprised a total of 54 pre-treatment study models of patients who had undergone successful surgical and orthodontic alignment of at least one PIC and had been selected for inclusion in a larger microcosting analysis study. Twenty-four subjects were treated at the RDE and 30 at the NDDH by the same combined orthodontic maxillofacial team.

Modified index of treatment need

The MIOTN used was a modification of the IOTN DHC. The IOTN DHC score of 5i for the PIC was excluded and the other features of the occlusion were graded. If the primary canine was *in situ*, it was excluded from the analysis, for example, the contact points between the primary canine and the adjacent lateral incisor and first premolar could not be scored. Two examiners used the IOTN ruler (Shaw *et al.*, 1991) to grade the study models using the MIOTN.

Statistical analysis

To test intraexaminer agreement, the pre-treatment study models from each district general hospital were re-examined 4 weeks after their initial examination. Two examiners independently graded the study models. Kappa statistics, which is a chance corrected measure of agreement (Landis and Koch, 1977), were used to analyse the results and evaluate the consistency of both intra- and interexaminer agreement.

Results

The unweighted kappa statistics for the two examiners, MBM (0.81) and STB (0.74), showed good intraoperator agreement. This is also illustrated in the pair plots for each examiner (Figure 1a,b). The unweighted kappa for the two operators showed a moderate level of interexaminer agreement (0.59).

All the patients in this study had PICs and were therefore placed into IOTN category 5i. The age at referral ranged from 10.9 to 43.1 years (median 13.5 years). When re-assessed using the MIOTN, the resultant scores for each examiner are illustrated in Figure 2a (MBM) and 2b (STB). It can be seen that for both examiners, 51 of 54 patients were subsequently re-scored to a lower IOTN category. For examiner MBM, 25 of 54 patients, and for examiner STB,



Figure 1 Pair plots for operators (A) MBM and (B) STB. Individual dots show good agreement for each of the 54 cases. Vertical lines show repeated measures with less agreement.



Figure 2 Distribution of patients in modified index of orthodontic treatment need (MIOTN) categories 1–5, for examiners (**A**) MBM and (**B**) STB.

22 of 54 patients were still in the two categories of highest need, namely 4 and 5, and so would still be in great or very great need of orthodontic treatment without the PIC. However, 11 and 14 patients, respectively, were subsequently rated as having MIOTN scores of 1 or 2 and so without the presence of the PIC would be deemed to have no or little need for orthodontic treatment under UK NHS guidelines. For both examiners, 18 patients were in MIOTN category 3, that is, a moderate need for orthodontic treatment if they had not otherwise had an impacted canine.

Discussion

There is an ever-increasing demand for orthodontic treatment and yet resources are limited and governed by the total funds available for health care. The allocation of resources within the NHS in the UK is based on need rather than demand, where need is determined by the IOTN. A subject presenting with a PIC is deemed to have an IOTN score of 5, that is, a very great need of treatment. However, the results from this study indicate that many

individuals presenting with a PIC do not require orthodontic treatment for other features of their occlusion. This confirms the anecdotal impression of Bass (1967). When the PIC score excluded and MIOTN score used to grade the other features of their occlusion, up to 14 of 54 cases were in either MIOTN grade 1 (no need of orthodontic treatment) or grade 2 (little orthodontic treatment need). Therefore, approximately 25 per cent of the subjects in this study underwent a minimum of 2 years of active orthodontic treatment to align a single tooth, or in the case of bilateral PIC, two teeth, incurring costs to both the NHS and the patient. These results reinforce the importance of early diagnosis and interceptive management of the PIC which may allow the PIC to erupt and obviate the need for further orthodontic treatment. This is especially relevant in cases with an MIOTN score of either 1 or 2 that have no or little need of orthodontic treatment for other features of their occlusion. If nothing is done, then later extraction of the permanent canine and restorative solutions to deal with the eventual loss of the primary canine are likely to be costly.

The majority of normally erupting maxillary canines should be palpable in the buccal sulcus by the age of 10-11 years (Ericson and Kurol, 1986). The Royal College of Surgeons Clinical Guidelines (Husain et al., 2004) advise that general dental practitioners should become suspicious of an ectopic canine position if the canines are not palpable by the age of 11 years or if palpation indicates an asymmetrical eruption pattern, then a radiographic examination is indicated (Ericson and Kurol, 1986). However, despite these recommendations, late referral of PICs continues to occur. Broadway and Gosney (1987) carried out a survey of the utilization of oral surgery services at a district general hospital and showed that 60 per cent of patients with impacted maxillary canines had not been referred to the department until 14 years of age. It is unlikely that removal of the primary canine in a subject older than 13 years will result in an improved canine position. In these cases, other management options must be considered. Certainly the average age of the patients in the current study was 13.5 years.

Two frequently quoted papers for the interceptive management of PICs are those of Ericson and Kurol (1988) and Power and Short (1993) which looked at the effect of the extraction of the primary canine on the eruption of the ectopic successor. Between 62 and 78 per cent of the previously ectopic permanent canines erupted into a satisfactory position. Neither of these studies had a control group.

More recently, Leonardi *et al.* (2004), in a prospective longitudinal study, evaluated the effectiveness of two interceptive approaches to PICs, the extraction of the primary canines either alone or in association with the use of a cervical pull headgear. Perhaps surprisingly, extraction of the primary canine alone had a success rate of only 50 per cent, which was not significantly greater than that of the untreated controls. The use of a headgear in addition to the extraction of the primary canine had a higher 80 per cent success rate. There was no significant difference between the two interceptive approaches in the time required for canine eruption.

Bruks and Lennartsson (1999) carried out a retrospective study comparing PICs successfully treated by interceptive extraction of either the primary canine alone or both the primary canine and primary first molar by the general dental practitioner (interceptive treatment group) and PICs referred to an orthodontic department for specialist treatment (corrective treatment group). The study analysed chronological age, dental age, and position of the canine at the time of recognition and referral. The authors found that age at the time of recognition and referral was the most important factor in determining the final outcome. Approximately one-third of the PICs in the corrective treatment group may have successfully erupted without corrective treatment if they had been diagnosed and treated with interceptive extraction of the primary canine at an earlier age.

The treatment of a PIC has been shown to take considerably longer than a similar malocclusion in which all the teeth have erupted, with a wide variation for individual cases. This has been reported to range from 23.9 to 31.1 months, dependent on the distance of the canine from the occlusal plane and also the age of the patient. For patients with a unilateral PIC, the treatment time was on average 3 months longer than for control patients with no impaction, and in the case of bilateral PICs the treatment time was on average 6 months longer (Iramaneerat *et al.*, 1998; Stewart *et al.*, 2001).

If the number of visits after exposure rather than months in treatment is considered, then the mean number of visits of forced eruption has been reported to be as high as 39.8 visits, with a range of 16-99 visits. This is over a mean period of 16.1 months with a range of 4-44 months (Zuccati et al., 2006). As discussed by Becker and Chaushu (2003), when planning the treatment of an impacted canine it must be integrated into the overall treatment plan. It is the first two parts of the described integration process that may indeed account, in part, for the increased treatment time. Firstly, space must be created in order to accommodate the canine, either by extraction or moving the adjacent teeth, and secondly the erupted maxillary and occasionally mandibular teeth must be included to provide anchorage to resist the forces required to align the canine.

When deciding on a treatment option for the management of a PIC, the age of the patient needs to be considered. This is especially valid if the MIOTN score is either a 1 or 2. An investigation into both the success rate and duration of treatment to align a PIC in a matched treatment sample, where the principal difference was age, reported a 100 per cent success rate for patients treated between 20 and 30 years of age, but only a 41 per cent success rate for patients over the age of 30 years (Becker and Chaushu, 2003). Although the study included only five canines in the group over 40 years of age, four of these failed to be extruded. Even though the success rate was 100 per cent in the 20- to 30-year age group, the overall treatment time and the number of visits were significantly greater in the adult groups than in an adolescent group. This is supported by Zuccati *et al.* (2006) who also reported a strong correlation between the number of appointment visits and the age of the patient (P < 0.001), with patients under the age of 25 years requiring considerably fewer treatment visits.

Interestingly, Stewart *et al.* (2001) found the converse, with treatment of impacted canines taking longer in the younger patient, although this may be explained by the fact that the younger patients presented with more severely impacted canines.

There are currently no studies evaluating the true cost of aligning a PIC, or indeed any other tooth. The majority of orthodontic costing studies have calculated the cost of orthognathic correction of dentofacial malocclusion (Lombardo et al., 1994; Dolan and White, 1996; Blakey and White, 1999; Panula et al., 2002; Kumar et al., 2006). The treatment of PICs frequently involves surgical exposure, often carried out under day case general anaesthesia, and subsequent orthodontic realignment involving multiple outpatient visits. Although the surgical procedure will involve a higher initial cost, the orthodontic costs will incur a considerable proportion of the total costs when one considers that realignment of the PIC often exceeds 2 years. The cost to the patient must also be recognized, including time taken off work and travel expenses for multiple appointments. In this study, 20-25 per cent of the sample were graded with a MIOTN score of 1 or 2 and therefore if the PIC was excluded, the patient would have little or no need for orthodontic treatment, perhaps only in the shorter term. If the PIC had been diagnosed at an earlier age, interceptive measures such as extraction of the primary canine alone may have obviated the need for surgery or orthodontic treatment.

Conclusions

The results of this study demonstrate that in the absence of a PIC, 20–25 per cent of the current sample of patients had a MIOTN score of either 1 or 2. These subjects would therefore be considered to have a malocclusion (excluding the impacted canine) with little or no need for orthodontic treatment. This therefore emphasizes the importance of early diagnosis of a PIC by the general dental practitioner and the need to institute interceptive measures where necessary. This is especially relevant when a patient would otherwise require no other orthodontic treatment.

Address for correspondence

Professor J. R. Sandy Child Dental Health University of Bristol Dental School Lower Maudlin Street Bristol BS1 2LY UK E-mail: jonathan.sandy@bristol.ac.uk

References

- Bass T B 1967 Observations on the misplaced upper canine tooth. Dental Practitioner and Dental Record 18: 25–33
- Becker A, Chaushu S 2003 Success rate and duration for orthodontic treatment of adult patients with palatally impacted canines. American Journal of Orthodontics and Dentofacial Orthopedics 124: 509–514
- Blakey G H, White R P 1999 Bilateral sagittal split osteotomies in an ambulatory care setting. Seminars in Orthodontics 4: 241–243
- Broadway R T, Gosney M B 1987 An assessment of the demands made by orthodontic conditions on the oral surgery facilities at one general hospital in southern England. Community Dental Health 4: 231–238
- Brook P H, Shaw W C 1989 The development of an orthodontic treatment priority index. European Journal of Orthodontics 11: 309–320
- Bruks A, Lennartsson B 1999 The palatally displaced maxillary canine. A retrospective comparison between an interceptive and a corrective treatment group. Swedish Dental Journal 23: 149–161
- Burden D J, Holmes A 1994 The need for orthodontic treatment in the child population of the United Kingdom. European Journal of Orthodontics 16: 395–399
- Burden D J, Mitropoulos C M, Shaw W C 1994 Residual orthodontic treatment need in a sample of 15- and 16-year-olds. British Dental Journal 176: 220–224
- Cooper S, Mandall N A, DiBiase D, Shaw W C 2000 The reliability of the Index of Orthodontic Treatment Need over time. Journal of Orthodontics 27: 47–54
- Department of Health 2008 Strategic commissioning of primary care orthodontic services. (http://www.18weeks.nhs.uk/Content.aspx?path=/ achieve-and-sustain/Specialty-focussed-areas/Oral-and-Maxillofacial-surgery-orthodontics/orthodontics)
- Dolan P, White R P 1996 Community hospital charges for orthognathic surgery. International Journal of Adult Orthodontics and Orthognathic Surgery 3: 253–255
- Ericson S, Kurol J 1986 Longitudinal study and analysis of clinical supervision of maxillary canine eruption. Community Dentistry and Oral Epidemiology 14: 172–176
- Ericson S, Kurol J 1987 Radiographic examination of ectopically erupting maxillary canines. American Journal of Orthodontics 91: 483–492
- Ericson S, Kurol J 1988 Early treatment of palatally erupting canines by extraction of the primary canines. European Journal of Orthodontics 10: 283–295
- Evans R, Shaw W 1987 Preliminary evaluation of an illustrated scale for rating dental attractiveness. European Journal of Orthodontics 9: 314–318
- Grainger R M 1967 Orthodontic treatment priority index. Public Health Service Publication No. 1000, Series 2, No. 25, US Government Printing Office, Washington, DC

- Husain J, Burden D, McSherry P 2004 The management of the palatally ectopic maxillary canine. Royal College of Surgeons of England Clinical Guidelines, London
- Iramaneerat S, Cunningham S J, Horrocks E N 1998 The effect of two alternative methods of canine exposure upon subsequent duration of orthodontic treatment. International Journal of Paediatric Dentistry 8: 123–129
- Kumar S, Williams A, Sandy J 2006 Orthognathic treatment: how much does it cost?. European Journal of Orthodontics 28: 520–528
- Landis J R, Koch C G 1977 The measurement of observer agreement for categorical data. Biometrics 33: 159–174
- Leonardi M, Armi P, Franchi L, Baccetti T 2004 Two interceptive approaches to palatally displaced canines: a prospective longitudinal study. Angle Orthodontist 74: 581–586
- Linder-Aronson S 1974 Orthodontics in the Swedish Public Dental Health Service. Transactions of the European Orthodontic Society pp.233–240
- Lombardo G A, Karakourtis M H, White R P 1994 The impact of clinical practice patterns on hospital charges for orthognathic surgery. International Journal of Adult Orthodontics and Orthognathic Surgery 4: 251–256
- Panula K, Keski-Nisula L, Keski-Nisula K, Oikarinen K 2002 Costs of surgical-orthodontic treatment in community hospital care: an analysis of the different phases of treatment. International Journal of Adult Orthodontics and Orthognathic Surgery 17: 297–306
- Power S M, Short M B 1993 An investigation into the response of palatally displaced canines to the removal of deciduous canines and an assessment of factors contributing to favourable eruption. British Journal of Orthodontics 20: 215–223
- Richmond S, Roberts C T, Andrews M 1994 Use of the Index of Orthodontic Treatment Need (IOTN) in assessing the need for orthodontic treatment preand post-appliance therapy. British Journal of Orthodontics 21: 175–184
- Richmond S *et al.* 1995 The relationship between the index of orthodontic treatment need and the consensus opinion of a panel of 74 dentists. British Dental Journal 178: 370–374
- Salzmann J A 1968 Handicapping malocclusion assessment to establish treatment priority. American Journal of Orthodontics 54: 749–765
- Shaw W C 1981 Factors influencing the desire for orthodontic treatment. European Journal of Orthodontics 3: 151–162
- Shaw W C, Richmond S, O'Brien K D 1995 The use of occlusal indices: a European perspective. American Journal of Orthodontics and Dentofacial Orthopedics 107: 1–10
- Shaw W C, Richmond S, O'Brien K D, Brook P 1991 Quality control in orthodontics: indices of treatment need and treatment standards. British Dental Journal 170: 107–112
- Stewart J A, Heo G, Glover K E, Williamson P C, Lam E W N, Major P W 2001 Factors that relate to treatment duration for patients with palatally impacted maxillary canines. American Journal of Orthodontics and Dentofacial Orthopedics 119: 216–225
- Summers C J 1971 A system for identifying and scoring occlusal disorders. American Journal of Orthodontics 59: 552–567
- Thilander B, Jakobsson S O 1968 Local factors in impaction of maxillary canines. Acta Odontologica Scandinavica 26: 145–168
- Wylie W L 1947 The assessment of anteroposterior dysplasia. Angle Orthodontist 17: 97–109
- Zuccati G, Ghobadlu J, Nieri M, Clauser C 2006 Factors associated with the duration of forced eruption of impacted maxillary canines: a retrospective study. American Journal of Orthodontics and Dentofacial Orthopedics 130: 349–356

Copyright of European Journal of Orthodontics is the property of Oxford University Press / UK and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.