Deep bite treatment in relation to mandibular growth rotation

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SUMMARY This paper illustrates some of the changes which occur during the treatment of Class II division 1 malocclusions complicated by a deep bite, and reviews the significance of these changes in relation to concepts of deep bite treatment. Particular reference is made to mandibular growth rotation and consequent differential tooth eruption in assessing factors involved in initial bite opening and consolidation of the opened bite. The cases shown illustrate that although an initial bite opening may occur by incisor intrusion and molar eruption, when viewed over a longer period of time rotational mandibular growth and associated differential eruption of teeth in which molars erupt more than incisors may be a more significant factor. Differential eruption which takes place in response to vertical condylar growth under guidance of the appliance would appear to be a significant factor in treatment of deep bite.

Introduction

Many biomechanical systems are currently used to correct deep bite during orthodontic treatment. The system of choice depends on the objectives of treatment: incisor intrusion, incisor protrusion and molar eruption, or extrusion. Incisor intrusion particularly of maxillary incisors is generally perceived to be the major biomechanical problem.

Incisor intrusion can convincingly be demonstrated using fixed or removable appliances (Begg, 1965; Booy, 1966; Sims, 1971; Burstone, 1977; Ten Hoeve et al., 1977; van Beek, 1985; Thompson, 1985; Dermaut and Vanden Bulcke, 1986; Levin, 1987). Molar extrusion or eruption induced by removable appliances, cervical headgear or intra oral elastics is an established clinical procedure.

Molar extrusion resulting in a backward mandibular rotation (Williams, 1965; Bijlstra, 1970) and opening of the bite is generally considered to be contra-indicated although recovery can be anticipated (Williams, 1965; Levin, 1977; van der Linden, 1988).

Most investigations and clinical reports have considered initial bite opening procedures and have not addressed the implications of rotational mandibular growth as described by Björk (1969), and Björk and Skieller (1972). Due to vertical condylar growth in forward mandibular growth rotation the mandible rotates around a fulcrum in the incisor or premolar region. In response to this growth, compensatory differential eruption takes place with molars erupting more than incisors. Differential tooth eruption associated with mandibular growth, and the influence of treatment on this growth and eruption would seem to be an important consideration when assessing the factors involved in the treatment of deep bite. The purpose of this paper is firstly to examine changes occurring during treatment of individuals with a Class II division 1 malocclusion complicated by a deep bite with particular reference to mandibular growth, and secondly, to review the significance of these changes in relation to the concepts of deep bite treatment.

The cases discussed were treated with the Begg light wire technique (Levin, 1987) and in one case an activator. The cases were all considered to have a forward type of mandibular growth rotation (Björk, 1969). A deep bite was diagnosed according to a textbook definition (Moyers, 1963) which states that a deep bite is present when mandibular incisors impinge on the palatal mucosa. For the purpose of analysis, tracings of lateral cephalometric radiographs were superimposed on SN and registered at S, on ANS and PNS registered at ANS, and the internal structures of the mandible (Björk, 1969).
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Initial bite opening

Initial bite opening during treatment with the light wire technique has been shown to result from incisor intrusion, molar eruption or a combination of these factors (Williams, 1965; Bijlstra, 1970; Thompson, 1985; Levin, 1987).

In non-growing individuals or dolichofacial types with a backward mandibular growth rotation tendency, incisor intrusion is the primary treatment objective. Initial incisor intrusion is illustrated in the first case report (Fig. 1B).

In growing individuals with deep bite and forward mandibular growth rotation both incisor-intrusion and molar eruption can initially be demonstrated (Fig. 2). An initial backward mandibular rotation may also occur when the rate of molar eruption exceeds the rate of vertical condylar growth resulting in bite opening caused by molar eruption. Excessive eruption is translated into a backward mandibular rotation (Fig. 2). However, molar eruption is not necessarily associated with backward mandibular rotation (Fig. 3). Provided that the rate of molar eruption does not exceed the relative rate of vertical condylar growth no backward rotation will occur.

It is clear on examination of treated cases that it is difficult to apportion the significance of incisor intrusion as opposed to molar eruption in opening the bite and the stability of the opened bite.

Figure 1  Treatment sequence in bite opening in a young post-adolescent female patient. (A) Pretreatment. The lower incisors impinge on the palatal mucosa. (B) After bite opening. Maxillary incisors are intruded and uprighted, with apices positioned directly beneath the cortical plate of the nasal floor. (C) Post-retention. Overbite stable, although with slight eruption of the incisors.

Figure 2  Treatment of a Class II division I malocclusion by extraction of second premolars and light wire technique. The overall superimpositions illustrate an initial backward mandibular rotation followed by a forward rotation.
Management of differential tooth eruption

Traditionally, mandibular molar elevation during treatment was found to cause bite opening and backward mandibular rotation. Backward rotation occurred around a fulcrum in the molar region and an axis near the condylar fossa. This concept of bite opening was based on cephalometric observations and a belief in linear facial growth. It had been developed prior to the Björk study on rotational facial growth (Björk, 1969) which results in differential tooth eruption and consequently the finding that molar eruption during growth was greater than had previously been believed (Björk and Skieller, 1972). It would seem likely that the management of this tooth eruption which occurs in response to vertical condylar growth would be a factor in the treatment of deep bite without causing inadvertent backward mandibular rotation. This concept can be illustrated by Fig. 4 and the following case reports.

The first case illustrates treatment using primarily an activator. The salient features of this abnormality are a deep bite, a so-called 'gummy smile', and maxillary prognathism. During treatment considerable mandibular growth associated with differential tooth eruption took place (Fig. 5). Maxillary prognathism and deep bite has been reduced. No active intrusion of incisors took place. The malocclusion has apparently been corrected as a result of mandibular growth and differential tooth eruption, molars erupting
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Figure 4 Diagram indicating (a) growth occurring away from the condylar fossa, with three different amounts of molar eruption (b), and their influence (a + b) on incisor position (c) and chin position (d). With excessive eruption backward rotation of the mandible would accompany bite opening. With non-eruption of the molars the mandible is advanced with forward rotation and deepening of the bite. Eruption and condylar growth are illustrated occurring away from condylar fossa and maxilla.

more than incisors. The result of this treated case brings into question the necessity to treat the maxillary prognathism by incisor intrusion. By improving the incisor inclination and altering the ratio of anterior maxillary height to anterior mandibular height by a mandibular height increase, the 'gummy smile' problem has been resolved.

The following case (Fig. 6) illustrates treatment of excessive overbite and overjet complicated by the premature loss of four first molars. The Begg light wire appliance was used. Considerable vertical height increase in the molar and premolar regions is evident. Despite active incisor intrusion the overbite appears to have been treated by molar eruption (Fig. 6f) associated with vertical condylar growth. The result is stable 7 years after retention.

Orthodontic treatment appears to have utilized inherent growth to establish Class I anterior occlusion. By correcting the anterior occlusion, forward mandibular growth rotation can occur around a fulcrum in the incisor region (Björk, 1969). Figure 6 illustrates forward mandibular rotation occurring subsequent to correction of the anterior occlusion (SN2–SN3).

The significance of vertical condylar growth and corresponding compensatory molar eruption during treatment is that it appears that the management of the mechanism of differential

Figure 5 Treatment with an activator. Note deep bite and maxillary prognathism. No intrusion of incisors. Correction seems to be the result of considerable mandibular growth. (a) Overall superimposition shows mandibular growth and relative rotational stability. (b) Maxillary and (c) Mandibular superimposition on internal structures illustrate considerable differential eruption and condylar growth. Molar eruption considerably greater than incisor eruption.
Figure 6  Class II division 1 malocclusion complicated by deep bite. Four first molars had been extracted prior to start of treatment. (6c) Overall tracings superimposed on SN. Slight backward rotation in first phase of treatment, followed by recovery with considerable mandibular growth. (6f) Superimposition on internal structures of the mandible. Growth rotation measured by change in inclination of SN. Between SN1 and SN2 no discernible rotation. From SN2 to SN3 indicative of forward mandibular rotation (Björk, 1969). Intra-oral views before treatment (above) and 6 years post-retention (below).
tooth eruption in response to condylar growth has the potential to be a significant factor in deep bite treatment. The differential eruption occurring during active guidance of fixed appliances and Class II elastics or the passive guidance of the activator appliance. Vertical condylar growth is also translated into mandibular growth reducing the sagittal jaw discrepancy.

Orthopaedic effects

In light wire treatment initial reduction of overbite and overjet may be considered a functional stage of treatment. During this phase of treatment a functional improvement of the occlusion and perioral musculature may occur (Fig. 7).

This case also illustrates a reduction in the skeletal discrepancy as a result of mandibular growth (Fig. 7). Bite opening is associated with incisor intrusion, molar eruption, and considerable condylar growth. No inadvertent backward mandibular rotation is evident.

The following cases illustrates a functional improvement of occlusion and perioral musculature. The result is stable 7 years after retention and the initial skeletal discrepancy has been resolved as a result of mandibular growth (Fig. 8). In assessing treatment changes it would appear that deep bite was resolved mainly as a result of mandibular growth occurring at the condyle and a consequent molar eruption greater than that of incisors. Maxillary molar eruption is obviously also important.

Figure 7 Functional improvement of perioral musculature during initial phase of treatment of Class II division I malocclusion (7c) Superimposition on SN. A reduction of skeletal Class II is evident with absence of backward mandibular rotation. Figure 7f) Superimpositions on maxillary and mandibular structures showing incisor intrusion, some molar eruption and considerable condylar growth. Photographs of patient before (above) and after (below) treatment.
Figure 8  Mandibular growth resulting in an orthopaedic effect. Result stable 6 years after retention. Considerable molar eruption with only slight incisor intrusion. Skeletal discrepancy reduced as a result of mandibular growth. (c) Tracings superimposed on SN. Considerable mandibular growth during treatment period. Slight horizontal growth after end of retention. (f) Mandibular superimposition showing molar eruption and considerable condylar growth. Intra-oral photographs before treatment and 6 years after retention.
Discussion and conclusions

Definite conclusions cannot be drawn from a number of selected cases. Nevertheless, certain observations may be made. These observations are based on individual cases and the likelihood that they are not unique. Similar cases when treated under similar circumstances may be expected to respond in an analogous fashion. Changes observed during treatment when viewed in the light of the Björk description of rotational facial growth and consequent differential tooth eruption may serve as a model for understanding some of the factors which may be involved in the treatment of deep bite.

Deep bite treatment is fundamentally a problem that should be resolved in relation to individual facial type and anticipated mandibular growth. Dolichofacial types tend to have relatively less mandibular molar eruption than brachyfacial types and greater incisor eruption (Björk and Skieller, 1972). Consequently, the resolution of a deep bite in growing individuals would appear to be a biomechanical problem requiring not only an emphasis on incisor intrusion or molar eruption, but also the evaluation and management of rotational facial growth and resulting differential tooth eruption.

The case reports in this presentation illustrate the use of Class II elastics and in one case an activator appliance in bite opening during treatment. The judicious use of Class II elastics in the light wire technique provides a means of managing the differential tooth eruption which occurs during treatment. Similarly, the passive imposition of an activator on the occlusal development can be shown to reduce deep bite during treatment presumably by altering the differential rates of tooth eruption.

Initially, bite opening in the light wire technique can be shown to occur by incisor intrusion, molar eruption and in some case by inadvertent backward mandibular rotation induced by molar elevation (Williams, 1965; Bijlstra, 1970; Thompson, 1985; Levin, 1987). Rotational stability of the mandible is influenced by the rate of molar eruption and the concomitant vertical condylar growth. Thereafter, it can be shown (Figs 3 and 6) as a result of vertical facial growth and vertical growth at the condyle that the initial incisor intrusion appears insignificant when compared to the considerable differential eruption of incisors and molars. Although initial incisor intrusion is important in establishing a normal anterior occlusion early in treatment the intrusion of incisors may be a relatively minor aspect of deep bite treatment when compared to the potential vertical eruption of molars occurring in response to rotational mandibular growth. After initial bite opening, differential tooth eruption, in which molars erupt more than incisors in forward mandibular growth rotation, may contribute to a consolidation of the opened bite and a long-term stability thereof.

Despite the complexity of fixed appliances, few publications have dealt with the orthopaedic effects of these appliances. Although Thompson (1985) found that mandibular growth was important in bite opening when using the light wire technique, and Petrovic (1984) stated that Class II elastics can significantly increase cellular activity in the mandibular condyle. This would enhance vertical growth. Gianelli et al. (1984) found that most treatment modalities influence the face in a similar manner, while Edwards (1983) and Mollenhauer (1987) reported on orthopaedic effects resulting from fixed appliance treatment. Several cases shown in this report illustrate a reduction in sagittal jaw discrepancy as a result of mandibular growth. This reduction in sagittal jaw discrepancy may be considered to be an orthopaedic effect occurring in association with bite opening.

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