CLINICAL RESEARCH

Occlusal Changes Following Posterior Tooth Loss in Adults. Part 1: A Study of Clinical Parameters Associated with the Extent and Type of Supraeruption in Unopposed Posterior Teeth

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Purpose: **One of the barriers to restoring an edentulous space may be the supraeruption of an unopposed tooth to occupy some or all of the space needed for prosthetic replacement. The aim of this study was to determine the extent and type of supraeruption associated with unopposed posterior teeth and to investigate the relationship between these and oral and patient factors.**

Materials and Methods: **Diagnostic casts of 100 patients with an unopposed posterior tooth and of 100 control patients were scanned and analyzed to record the extent of supraeruption, together with other clinical parameters. The type of eruption present was defined for each subject as Periodontal Growth, Active Eruption, or Relative Wear. Generalized Linear Models were developed to examine associations between the extent and type of supraeruption and patient or dental factors. The extent of supraeruption for an individual was modeled to show association between the degree of supraeruption and clinical parameters. Three models were produced to show associations between each type of supraeruption and clinical parameters.**

Results: **The mean supraeruption for subjects was 1.68 mm (SD 0.79, range 0 to 3.99 mm) and for controls, 0.24 mm (SD 0.39, range 0 to 1.46 mm). The extent of supraeruption was statistically greater in maxillary unopposed teeth than in mandibular unopposed teeth. Supraeruption was found in 92% of subjects' unopposed teeth.**

Conclusions: **A Generalized Linear Model could be produced to demonstrate that the clinical parameters associated with supraeruption are periodontal growth, attachment loss, and the lingual movement of the tooth distal to the extraction site. Three types of supraeruption, which may be present singly, or in combination, can be identified. Active eruption has an association with attachment loss. Periodontal growth has an inverse association with attachment loss, is more prevalent in younger patients, in the maxilla, in premolars, and in females. Relative wear has an association with increasing age and is more prevalent in unopposed mandibular teeth.**

INDEX WORDS: supraeruption, unopposed, Generalized Linear Modeling, overeruption

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RECENTLY, there has been an increase in interest in dental changes following the loss of posterior teeth, particularly in adults.[1-3] This series of three articles attempts to identify the clinical parameters associated with these changes. The articles will address parameters associated with the degree of supraeruption, the type of supraeruption, non-vertical tooth positional changes, and the prevalence of occlusal interferences associated with the site of tooth loss.

One of the tooth positional changes creating difficulty in restoring some mutilated dentitions is the presence of supraeruption. The actual mechanism of the eruptive movement in adults is not clearly understood,[4,5] although several treatments have been advocated for its correction. It would be helpful to have knowledge of patient and dental factors associated with supraeruption.

The teeth most likely to become unopposed, and therefore susceptible to supraeruption, are those occluding against edentulous segments. Battistuzzi et al[6] and Marcus et al[7] found that the most commonly missing posterior tooth was the first permanent molar, followed by the second molar, second premolar, and finally the first premolar. Meskin and Brown[8] reported that mandibular posterior teeth were more likely to be missing than maxillary posterior teeth, and that with increasing age, posterior teeth were more likely to be missing bilaterally. We may therefore speculate that in our aging population there will be an increasing number of partially dentate elderly patients in need of prosthetic replacement of missing posterior teeth.[9]

The necessity of replacing missing teeth has been discussed in the literature for some years. Hirschfield[10] postulated that the loss of a posterior tooth could result in drifting, torsion, and elongation of teeth associated with the edentulous space created by the missing tooth. He postulated that these positional changes were likely to lead to root exposure, traumatic occlusion, soft tissue trauma, furcation exposure, plaque retention and its associated disease processes, plus retardation or acceleration of occlusal wear. However, replacement of missing teeth is not without biological cost in terms of plaque retention and periodontal disease.

Craddock and Youngson[1] and Kiliaridis et al[2] found that up to 83% of unopposed posterior teeth showed signs of supraeruption. The first article demonstrated that 32% of teeth had supraeruption in excess of 2 mm, 6.7% were in excess of 3 mm, and one tooth demonstrated supraeruption of 5.39 mm. Killiaridis et al[2] identified that supraeruption greater than 2 mm occurred in 24% of unopposed teeth, with 18% having no demonstrable supraeruption. In other words, 82% demonstrated some supraeruption, which in terms of restoration could be clinically significant.

Few studies have investigated the type of eruptive process. Compagnon and Woda[11] studied the unopposed maxillary first molar in both healthy mouths and those with periodontal pathology present. In healthy individuals, they noted that the gingival margin remained at its original level on the tooth during this occlusal movement. This movement, whereby the periodontal ligament and bone develop together with the erupting tooth, was described as periodontal growth. Compagnon and Woda also found that after ten years of remaining unopposed, this reversed, and recession and root exposure occurred. They described this as passive eruption (as distinct from active eruption, where the tooth continues to move in an occlusal direction in the absence of periodontal growth). From these findings it is obvious that the appearance of supraeruption may have several components, including periodontal growth, passive eruption, and active eruption.

Ainamo and Talari[12] considered the change in width of the attached gingiva following loss of an opposing tooth. They noted that unopposed teeth continue to erupt following the loss of an antagonist. The supporting structures also developed vertically to follow tooth eruption. The patients in the study were mainly middle aged.

Factors associated with the presence, extent, and type of supraeruption were not investigated by previous authors, and this study attempts to identify these factors and explore their influence on the degree of supraeruption measured for individual teeth.

The objectives of this article were to investigate potential differences in vertical position of unopposed posterior teeth and unopposed teeth in a matched control group; to investigate potential relationships between clinical parameters and supraeruption in unopposed posterior teeth; and to determine the type of eruptive process and investigate the relationship between type of eruption occurring and related oral and patient factors.

Materials and Methods

To investigate supraeruption in unopposed posterior teeth it was necessary to identify the presence of supraeruption and measure its extent. It was also necessary to classify the type of eruption detected and to explore the patient and dental factors associated with the extent and type of supraeruption.

Associations between clinical parameters and supraeruption were assessed using appropriate statistical methods.

Local ethical committee approval was gained. Patients from Leeds Dental Institute with an unopposed posterior tooth were invited to take part in the study. For the purposes of this study "posterior" was defined as a maxillary or mandibular first or second premolar; or first, second, or third molar. "Unopposed" was defined as 20% or less of the occlusal surface in contact with an opposing tooth when examined in the intercuspal position. When more than one tooth in the same quadrant was unopposed, the tooth nearest to an antagonist was observed. Adult patients aged 18 years or older, who had teeth missing for over 5 years, were included. Written informed consent was obtained from all subjects following a written and verbal explanation of the purpose of the study and methods to be used in the investigations.

Patients without documentary evidence showing that the tooth under investigation had been unopposed for a minimum period of 5 years were excluded from the study. Patients with unopposed teeth prevented from independent movement by involvement in support or retention for fixed or removable prostheses were also excluded.

One hundred consecutive patients with an unopposed posterior tooth were invited to take part in the study. One hundred age- and sex-matched subjects, with matching interdental bone height at the sites examined were recruited as controls. Matched bone height was within 1 mm of that of the subjects, as measured on radiographs taken within the last 2 years (bitewings, periapicals, or panoramic films). The local ethics committee governing clinical research felt that additional radiographs were not justified for the purposes of this study. Impressions for study casts were made using Kromopan® alginate impression material (Lascod, Italy), using Fix (DeTrey, Weybridge, UK) tray adhesive. Orthodontic stock impression trays were used (Orthocare, Bradford, UK). Prior to casting, the impressions were disinfected in Perform, (Schulke and Mayer, Norderstedt, Germany). Study casts were poured in Dentstone KD model stone (British Gypsum, Newark, UK). Trimmed casts were scanned using the Black Widow 9636 USB 3D scanner (Devcom Ltd, Sterling, UK). Direct measurements of casts were made using a dial gauge type 5921 micrometer (Measy, Gland, Switzerland). Analysis of scanned images was carried out using QuickCAD Millenium Edition software (Autodesk Ltd, Surrey, UK).

Alginate impressions (Kromopan®, Lascod, Italy) were taken of the maxillary and mandibular jaws. Following disinfection, these were cast immediately (Dentstone KD, British Gypsum Products, Newark, UK). Study casts were trimmed in a seven-sided configuration, so the buccal plane would lie parallel to the scanner surface when the casts were placed on it. The casts were scanned with a millimeter scale rule included in each image at a resolution of 1401 DPI at 50% scale in full color. The images were stored in Microsoft "Picture it" format to retain the 3D quality of the image.

Vertical Overlap

This was determined by the degree of vertical overlap between the maxillary and mandibular incisor teeth, and coded 0 to 3. Zero indicated no overlap or an anterior open bite, "1" was coded for up to 1/3 of the mandibular incisor overlap, "2" indicated between 1/3 and 2/3 vertical overlap, and "3" indicated in excess of 2/3 overlap. The maximum value was recorded for each subject.

Overjet

This was measured using a dial gauge at the central point on the incisal edge of the maxillary right central incisor.

Buccal occlusion

This was assessed according to the degree of cuspal interdigitation. This was the degree of cusp/fossa fit of the buccal cusps of the posterior teeth. Perfect cusp fossae fit was coded "0" imperfect fit, but not cusp-to-cusp relationship was coded "1" and cusp-to-cusp relationship was coded "2."

Crowding

To assess the role of crowding in post extraction tooth position, the degree of crowding present at the time of examination in the arch that had undergone the extraction was assessed using a Peer Assessment Rating (PAR) ruler (Orthocare, Bradford, UK). The score for each mandibular incisor contact displacement, from the mesial surface of the left canine to the mesial surface of the right canine, was recorded. The scores were then added to give the overall incisor crowding score.

From each cast the following measurements were made, where appropriate, using Quick-Cad analysis software:

The *degree of supraeruption* was measured from the occlusal curve to the tip of the most occlusally projecting

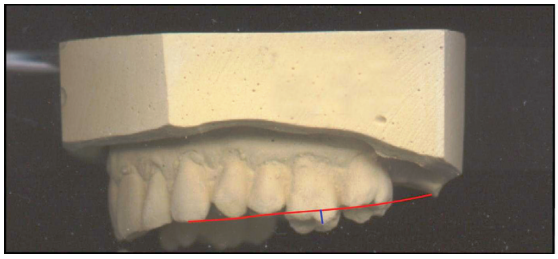

Figure 1. Measurement of supraeruption of an unopposed tooth.

buccal cusp in a direction closely following the long axis of the tooth (Fig 1).

To determine the *degree of tipping*, the long axis of the tooth under investigation was determined to be the line drawn from the cusp tip to the midpoint of the widest part of the crown for premolars, and for molar teeth, from the deepest point on the buccal fissure to the midpoint of the maximum mesiodistal crown convexity. The occlusal curve was transferred to the opposing arch to measure the degree of tipping of the teeth adjacent to the extraction/edentulous site. A perpendicular line was drawn from a tangent to the occlusal curve, and the angle between this and the long axis of the tooth was recorded (Fig 2).

Rotation was determined as follows: the buccolingual axis of the tooth under investigation was determined to be a line drawn between the buccal and lingual cusp tips in premolars. In the case of mandibular second premolars, where there was not a distinct lingual cusp, a line was drawn between the buccal cusp and the midpoint on the mesiodistal width of the tooth. For molars, a line was drawn between the buccal fissure and the midpoint on the mesiodistal width of the tooth.

The *archform curve* was determined by drawing a "spline" curve from the cusp tips of the functional teeth in the arch. From the point on the curve where the long axis of the tooth under investigation intersected, a tangent was drawn, from which a perpendicular line could be derived. The angle between the buccolingual axis of the tooth (purple) and the perpendicular line (green) was recorded as the amount of tooth rotation (Fig 3).

To determine the *buccolingual tooth position*, the arch form, as determined by the cusp tips of the functional adjacent teeth, was drawn using a "spline" curve (shown in red in Fig 4). The maximum displacement of a buccal cusp of the unopposed tooth was determined and is shown in blue.

Casts with supraeruption present were classified as displaying one or more of three types of supraeruption. These were periodontal growth, active eruption, and relative wear.

A spline curve was drawn to represent the curve produced by the maximum concavities of the gingival margins of the buccal teeth on the arch to be observed. The tooth under investigation was not included in the determination of the curve. Similarly, the cusp tips were joined with a spline curve, to show if eruption below the occlusal curve had taken place. When vertical tooth movement beyond the occlusal plane, accompanied by alveolar development of the gingival margin beyond the gingival curve, was present, this was recorded as periodontal growth. Eruption of the tooth

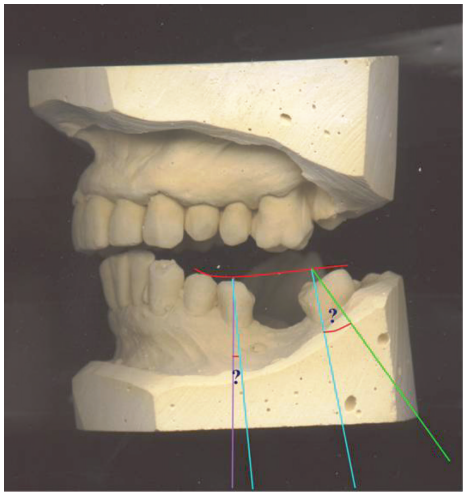

Figure 2. Determination of tooth tip.

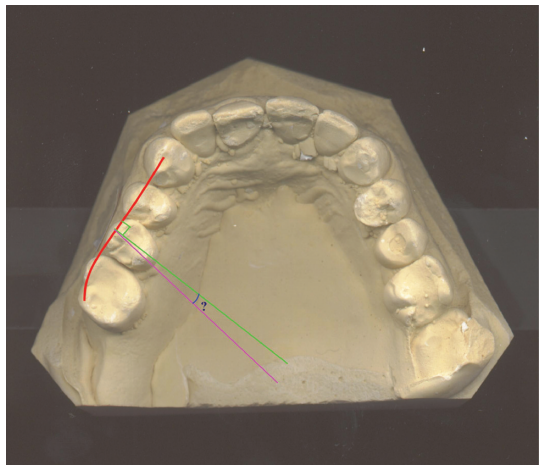

Figure 3. Determination of rotation.

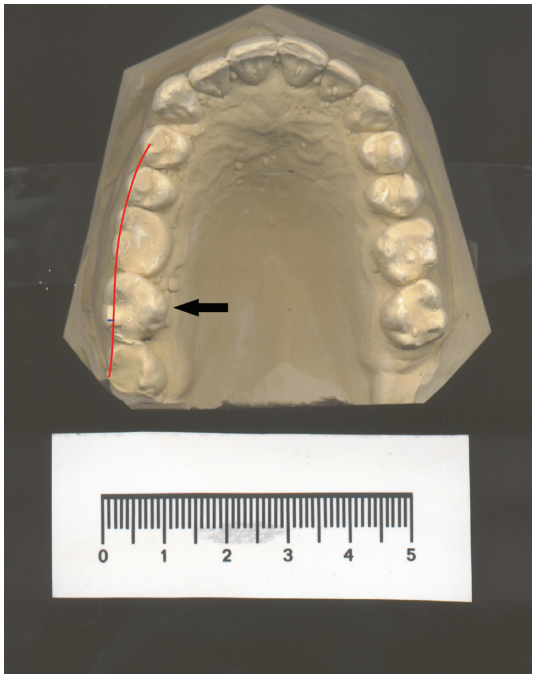

Figure 4. Determination of buccolingual displacement.

under investigation beyond the occlusal curve, with the gingival level remaining consistent with that of the adjacent teeth, was recorded as active eruption. Where the appearance of vertical tooth movement was due to wear of the adjacent teeth, a recording of relative wear was made using radiographs (Fig 5) to assess relative cusp tip wear. It was not possible to use existing indices of tooth wear, as they did not have any specific criteria for assessing loss of cusp height. The identification of each type of eruption is shown in Figure 6.

Data analysis was divided into two parts: basic data screening and Generalized Linear Modeling.

Exploratory data analysis was undertaken using a number of statistical methods including examination of means and distributions, scatterplots, boxplots, and relative risk tables to examine trends and associations within the data set.

Using Generalized Linear Modeling, a model was developed to examine associations between the extent and type of supraeruption and patient factors and/or the type of supraeruption present.

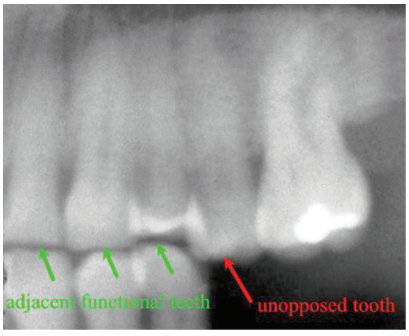

Figure 5. Radiographic assessment of relative wear.

Results

Intra-examiner reliability was assessed using Bland-Altman plots and Kappa scores as appropriate. Reliability was found to be satisfactory.

Ninety-two percent of unopposed teeth displayed supraeruption. Supraeruption in the subject group was in excess of 1 mm in 68% of cases and in excess of 2 mm in 27% of cases, compared with controls, where 8% of cases had supraeruption in excess of 1 mm and none had supraeruption in excess of 2 mm. The mean supraeruption for subjects was 1.68 mm (SD 0.79, range 0 to 3.99 mm) and for controls, 0.24 mm (SD 0.39, range 0 to 1.46 mm). The mean difference between the groups was 1.44 mm (95% CI 1.24,1.63) (Fig 7). There was a statistically significant difference between the two groups as demonstrated by the 95% confidence intervals.

A significant difference between the extent of eruption in maxillary and mandibular teeth is demonstrated by the 95% confidence intervals (Table 1). Supraeruption was statistically greater in maxillary unopposed teeth than mandibular.

The extent of supraeruption in molars and premolars was compared and found not to be of significance (Table 2).

Active eruption was the most common eruptive process, followed by periodontal growth and relative wear as shown in Table 3.

Generalized Linear Models of the degree of supraeruption, incidence of periodontal growth, incidence of active eruption, and incidence of relative wear were produced and are shown in Tables 4–7, respectively.

The residual deviance and the standardized residuals and leverages indicate that the models adequately fit the data.

Discussion

The results of this study are consistent with other investigations of the incidence of supraeruption, but other work has lacked comparison with a

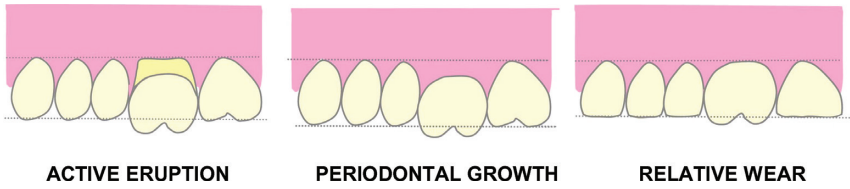

Figure 6. Type of supraeruption.

matched control group. This investigation found that 92% of teeth had some degree of supraeruption, while the control group had 33% of teeth displaying some degree of supraeruption. The use of a "spline" curve to represent the natural occlusal curve may provide an explanation for what may appear to be a significant degree of supraeruption in patients without unopposed teeth. This is demonstrated in Figures 8 and 9 and illustrates that by not including the reference point for the tooth under investigation, as is needed when a tooth is unopposed, a flattening of the curve is created. As the reference point for the control tooth was not included in the "spline" curve determination, the flattening thus produced could make a normally erupted tooth appear to be slightly supraerupted. Both Kiliaridis[2] and Shugars[13] measured supraeruption from a straight line drawn between two points on the cusp tips of the teeth adjacent to the extraction site. This is unlikely to simulate the occlusal curve with a great degree of accuracy, and as the flattening of the curve may produce a false impression of supraeruption, a straight representation of this portion of the curve would increase this possibility.

The flattening of the curve would be of most significance in patients with a small-radius occlusal curve, as the greater radius curves would tend more towards a straight line. Lynch and McConnell[14] suggested that when the skeletal relationship of the jaws differed from the ideal class I relationship, the radius of the generated curve should be increased or decreased accordingly. This was originally advocated by Needles[15] in his studies of geometric occlusal relationships.

It is therefore more important to examine the difference in the degree of measured "supraeruption" rather that merely its apparent presence. Unopposed teeth had a mean supraeruption of 1.68 mm, while the control teeth had a mean supraeruption measurement of 0.24 mm.

The fact that the control teeth were in occlusion at the time of measurement does not exclude the possibility that at some time in the past, some of the control teeth may have been unopposed for a time, due to delayed eruption of its antagonist, loss

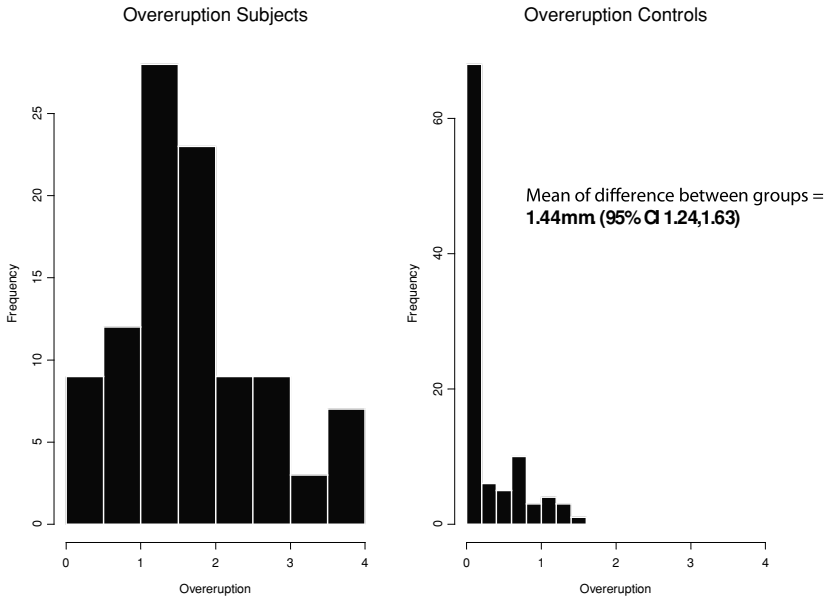

Figure 7. Distribution of supraeruption in the subject and control groups. Mean = 1.7 mm, 95% confidence interval (1.5, 1.9)

Table 1. Supraeruption in Maxillary and Mandibular Teeth

Group	*Mean (mm)*	*Standard Deviation*	*Range (mm)*
Maxillary	1.91	0.90	0–3.99
Mandibular	1.03	0.87	0–3.28

95% confidence interval in maxillary teeth is 1.70, 2.12. 95% confidence interval in mandibular teeth is –0.67, 1.36.

of a restoration in the tooth under investigation or its antagonist, or the fact that the antagonist may have been missing and later undergone prosthetic replacement.

The main limitation of a cross-sectional study is that no cause and effect relationship can be established for the observations obtained. A longitudinal study over a period of 5 to 10 years following a posterior tooth extraction would have enabled a direct causal relationship to be developed, and in environments where patients are more likely to return to the same dental care provider over this period of time, this would have been ideal. It would also have been of interest to have the age of the patient at the time of extraction available for comparison; however, due to unavailability of previous records, this was not possible.

Therefore, this study records the changes following posterior tooth loss, but cannot describe the rate of change, or which age groups are most susceptible to undesirable movement following extraction.

The linear predictor of the extent of supraeruption could be described by the covariates attachment loss, periodontal growth, and the lingual position of the tooth distal to the extraction site. It is interesting that periodontal growth, which may also be considered to be vertical development of the alveolar process, was a key predictor of extent or degree to which a tooth may overerupt. It is also

Table 2. Supraeruption in Molars and Premolars

Group	*Mean (mm)*	*Standard Deviation*	*Range (mm)*
Molars	1.66	1.02	0–3.99
Premolars	1.77	0.73	0–3.62

95% confidence interval in molars is 1.43, 1.89. 95% confidence interval in premolars is 1.42, 2.10.

Table 3. Frequency of Each Type of Eruption

Active Eruption	*Periodontal Growth*	*Wear*	*None*
62	44	27	8

not unusual that a sample of the population with the mean age found in this group (50 years) would also have some degree of periodontal attachment loss. It is unclear why the lingual position of the tooth distal to the site of tooth loss should influence the eruptive potential of the unopposed tooth. The comparison of extent of buccolingual tipping between the subject and control groups showed no statistically or clinically significant differences, and one may postulate that the tooth distal to the site of tooth loss may have exhibited this degree of tipping before the adjacent tooth was lost.

The extent of supraeruption is likely to impact upon both the feasibility of replacement of the missing tooth and the treatment necessary to correct or compensate for supraeruption. At the one extreme, the extent of supraeruption was almost 4 mm, and it is unlikely that successful treatment could be achieved by restorative treatment alone. The frequency and extent of supraeruption possible means that frequent monitoring of unopposed teeth should be advocated. Correction of some extreme vertical movements may be impractical or impossible. The use of simple techniques to prevent supraeruption, such as that described by Solnit,[16] may be useful in some cases; or where the extraction site is bounded, the use of a temporary

Table 4. Model and Estimates for Extent of Supraeruption

$$OE_i \sim N\,(\mu_i, \sigma)\;\mu_i = 0.74 + 0.31\,AL_i + 0.65PG_i + 0.29LB_i$$

Degree of Supraeruption	*Value*	*95% CI*
Intercept	0.74	0.25 to 1.23
Attachment loss	0.31	0.14 to 0.48
Periodontal growth	0.65	0.28 to 1.02
Lingual movement of B	0.29	0.47 to 1.11

Residual deviance: 39 on 70 degrees of freedom

Where OE_i is the outcome for an individual, N is the normal distribution, AL_i is the attachment loss of the unopposed tooth. PG_i is the presence of periodontal growth, LB_i is the lingual movement of the tooth distal to the extraction site.

Table 5. Model and Estimates for Periodontal Growth

$$PG_i \sim N(u_i,\sigma)\ \mu_i = 4.01 - 0.06AGE_i - 0.93AL_i + 2.25AR_i - 2.0TT + 1.16SEX_i$$

Periodontal Growth	*Value*	*95% CI*
Intercept	4.06	1.12, 7.0
Age	−0.06	−0.10, −0.02
Attachment loss	−0.93	−1.52, −0.34
Arch	2.25	0.82, 3.68
Tooth type	−2.00	−3.33, −0.67
Sex	1.06	0.0, 2.12

Residual Deviance: 90 on 94 degrees of freedom

Where PG_i is the outcome for an individual, N is the normal distribution, AGE_i is the age of the subject, AL_i is the attachment loss of the unopposed tooth, AR_i is the arch in which the unopposed tooth lies, TT_i is the tooth type, either molar or premolar, SEX_i is the sex of the subject.

prosthesis may be all that is required before definitive restoration. In unbounded sites an adhesive cantilever prosthesis such as those described by Jepson and Allen[17] may be useful.

Three types of supraeruption, which may be present singly, or in combination, can be identified. Active eruption has an association with attachment loss. Periodontal growth has an inverse association with attachment loss, is more prevalent in younger patients, in the maxillary arch, in premolars, and in females. Relative wear has an association with increasing age and is more prevalent in unopposed mandibular teeth.

Periodontal growth was more prevalent in the maxilla. It may be postulated that a number of factors may influence this, including a more trabecular bone structure, thinner cortical plate, and a better blood supply than the mandible. The muscular influences of the tongue on tooth position will be different, particularly in respect to the resting

Table 6. Model and Estimates for Active Eruption

$$AE_i \sim N(u_i, \sigma)$$
$$\mu_i = -0.06 + 1.04AL_i - 2.1PG_i$$

Active Eruption	*Value*	*95% CI*
Intercept	−0.6	−2 to 0.8
Attachment loss	1.0	0.4 to 1.6
Periodontal growth	−2.1	−3.16 to −1.12

Residual Deviance: 92 on 97 degrees of freedom

Where AE_i is the outcome for an individual, N is the normal distribution, AL_i is the attachment loss of the unopposed tooth, PG_i is periodontal growth.

Table 7. Model and Estimates for Relative Wear

$$RW_i \sim N(u_i, \sigma)\ \mu_i = -2.33 + 0.04AGE_i - 1.14AR_i$$

Relative Wear	*Value*	*95% CI*
Intercept	−2.33	−4.33 to −0.33
Age	0.04	0 to 0.08
Arch	−1.14	−2.14 to −0.14

Residual Deviance: 107on 97 degrees of freedom

Where RW_i is the outcome for an individual, N is the normal distribution, AGE_i is the age of the subject, AR_i is the arch in which the unopposed tooth lies.

position of the tongue on the occlusal surfaces of the mandibular teeth.[18,19]

The cumulative effects of periodontal breakdown are encountered with increasing age.[20] If periodontal disease were an element in attachment loss in unopposed teeth, it would be seen less in younger subjects. Periodontal attachment loss is also more commonly seen in sites where good oral hygiene is more difficult to maintain.[21,22] The effects of gender on the prevalence of periodontal disease are not clearly understood, and research offers conflicting evidence of the effect of gender on the disease.

Attachment loss was one of the main predictors of active eruption. The negative correlation with periodontal growth is a key finding, indicating that as the likelihood of exhibiting active eruption increases, the presence of attachment loss increases, and periodontal growth (i.e., vertical development with maintenance of attachment) is reduced. A further longitudinal study will be needed to determine if the appearance of active eruption is the result of a physiological process (periodontal growth) and a pathological process (periodontal attachment loss) taking place simultaneously or intermittently at an individual unopposed site. It would need to be established that active periodontal breakdown was taking place at the same overall time and rate as eruptive tooth movement.

The presence of active eruption will inevitably alter the crown–root ratio, affecting the mechanical characteristics of the tooth and its behavior under functional loading. This alteration in crown-root ratio may be the major factor in the production of drifting in teeth with reduced periodontal support.[23]

The anatomy of the tooth in question may have implications where active eruption is encountered. In teeth with root furcations, these may become

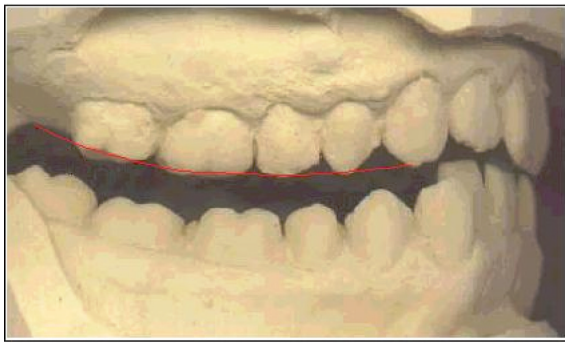

Figure 8. Occlusal curve generated when the maxillary first molar is included in the determination of the curve.

exposed, and/or create plaque traps that may compromise the periodontal health. Exposure of root surface may also precipitate pulpal sensitivity and root caries and create esthetic compromise.

The "pseudo-eruptive" appearance of relative wear is associated with increasing age in an individual and is most prevalent when there is a mandibular tooth unopposed. Although it is easy to understand why the cumulative effects of physiological wear on adjacent teeth are more likely to be seen in older subjects, it is unclear why there should be a discrepancy between the arches. One possibility is that in this study there were only approximately 25% of unopposed sites involving the mandibular arch, and also a disproportionately small number of subjects displaying relative wear. These two factors combined could mean that the total number of unopposed mandibular sites with relative wear was small, and the analysis may have found an incidental statistical finding. The number of years a tooth has remained unopposed may have an effect on the relative wear of functional and non-functional teeth, and it is accepted that the absence of knowledge of this covariate somewhat limits the information provided in this model.

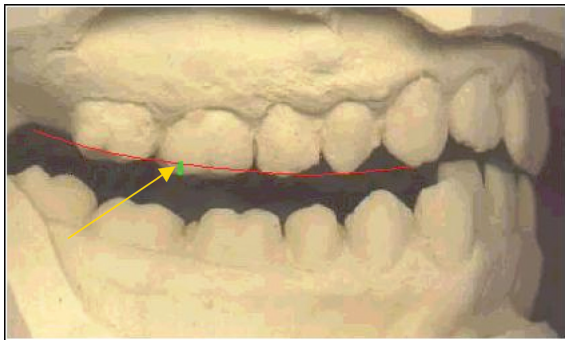

Figure 9. Occlusal curve generated when the maxillary first molar is excluded from the determination of the curve.

Distortion of the occlusal plane due to wear of functional teeth associated with unopposed teeth often requires complex and extensive restorative treatment, directed at restoring coronal height of the worn teeth, and possibly necessitating an increase in the occlusal vertical dimension. However, if other types of eruption co-exist with wear, issues relating to gingival level and furcation exposure may further complicate treatment planning.

Overall, the development of each type of supraeruption appears to have associations primarily with age, attachment loss, and the arch in which the unopposed teeth lie. Active eruption is associated with loss of attachment, while the reverse is true for periodontal growth. Increasing age is also a covariate in the model of relative wear.

Conclusions

In this study, supraeruption was found in 92% of unopposed teeth.

The mean supraeruption measurement for unopposed teeth was 1.68 mm, compared with 0.24 mm for the control group.

Supraeruption was more prevalent in the maxillary arch and associated with a reduction in periodontal attachment.

Three types of supraeruption, which may be present singly, or in combination, were identified.

Active eruption had an association with attachment loss.

Periodontal growth has an inverse association with attachment loss, was more prevalent in younger patients, in the maxillary arch, in premolars, and in females.

Relative wear has an association with increasing age and was more prevalent in unopposed mandibular teeth.

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