INFLUENCE OF NUTRITIONAL STATE ON RADIOGRAPHIC VARIABLES IN UPPER CANINE TEETH

Luis F. Wuscovi¹, Hugo N. Aragón², María E. Gordillo³, María E. López³

¹ Department of Radiology, ² X-Ray Room and ³ Department of Biological Chemistry. School of Dentistry, Universidad Nacional Tucumán.

ABSTRACT
Permanent upper canine tooth impaction is related to both genetic causes and nutritional and local causes. Based on radiographic studies of children, Haavikko, 1974, calculated the median of the degree of calcification for each tooth according to age. The aim of our study was to establish associations between certain radiographic variables with respect to upper canine tooth buds and nutritional state in a population of schoolchildren. Thirty-three children of chronological ages 3 to 9 years from a population of rural schoolchildren took part in the study. The children were classified into three groups: malnourished, control and overweight. For the radiographic study we used a systematized technique using DSJ 70kV radiographic equipment with 8 mA and Insight intraoral film (E F speed; Eastman Kodak, Rochester, NY). The images obtained from the 66 radiographic studies were scanned. The program Image tool for Windows was used to measure: a) distance from the canine cusp to the intermaxillary suture, b) outer angle formed between the axis of the canine tooth and the plane that cuts the intermaxillary suture perpendicularly, c) degree of calcification d) presence of supernumerary teeth. The values of these variables were analyzed statistically with the Kruskal-Wallis test of the SPSS program. The results were: a) For the distance variable there is no significant difference between the malnourished and control groups (p>0.05), although there are differences (p<0.001) between the control and overweight groups; b) There is no significant difference between nutritional states for the angle variable; c) For the ratio between chronological age and dental age calculated according to degree of calcification, significant differences were found between the malnourished and overweight groups (p< 0.01), while the control group showed no difference regarding Haavikko’s values (p>0.05). Both the distance of the canine tooth bud and its degree of calcification vary in patients with nutritional disorders, therefore it would be useful to conduct a radiographic study at school age to detect tooth anomalies and reduce their consequences.

Key words: radiographic studies, nutritional state, canine tooth bud.

RESUMEN
La retención de los caninos superiores permanentes se encuentra asociada tanto a causas genéticas como nutricionales y locales. A partir de estudios radiográficos en niños, Haavikko, 1974, calculó la mediana del grado de calcificación de cada pieza dentaria según la edad. El objetivo de este estudio fue establecer asociaciones entre ciertas variables radiográficas respecto al germen de los caninos superiores y al estado nutricional de una población escolar. Se trabajó con 33 niños de edad cronológica entre 3 y 9 años de una población escolar rural. Se clasificaron los niños en los grupos desnutrido, control y sobrepeso. Para el estudio radiográfico se aplicó una técnica sistematizada utilizando un equipo radiográfico DSJ de 70kV con 8 mA y películas intraorales Insight (E F speed; Eastman Kodak, Rochester, NY). De los 66 estudios radiográficos obtenidos se escanearon las imágenes. Con el programa Image tool para Windows se midieron: a) distancia de cúspide de canino a sutura intermaxilar b) ángulo externo formado entre el eje del canino y el plano que corta la sutura intermaxilar en forma perpendicular c) grado de calcificación d) presencia de dientes supernumerarios. Los valores de estas variables se analizaron estadísticamente con el test de Kruskal-Wallis del programa SPSS. Los resultados fueron: a) Para la variable distancia no existen diferencias estadísticamente significativas entre los grupos desnutrido y control (p>0,05), aunque existen diferencias (p<0,001) entre los grupos control y sobrepeso; b) No existen diferencias significativas entre los estados nutricionales para la variable ángulo; c) Para la relación entre la edad cronológica con respecto a la edad dental calculada a través del grado de calcificación, se observaron diferencias significativas entre los grupos desnutrido y sobrepeso (p< 0,01), en tanto que el grupo control no presentó diferencias con respecto a los valores de Haavikko (p>0,05). Tanto la distancia del germen del canino como su grado de calcificación varían en pacientes con trastornos nutricionales por lo que sería de utilidad la aplicación de un estudio radiográfico a edad escolar para detectar anomalías dentarias y reducir sus consecuencias.

Palabras clave: estudios radiográficos, estado nutricional, germen canino.
Permanent upper canine teeth follow third molars in frequency of impaction, with an incidence of 0.8 to 2.8% \(^1\), which has been found to be 2.2% for populations of Swedish schoolchildren \(^2\) and 3% for a Saudi population\(^3\). Frequency of impaction is three times higher in females than in males\(^5\). The causes of canine tooth impaction may be general or localized\(^6\). Generalized causes include endocrine deficiencies, febrile diseases and radiation, while localized causes are most often the case in impaction, and include such causes as discrepancy between arch length and tooth size, lengthy impaction or premature loss of the deciduous canine tooth, abnormal position of the tooth bud, defect of the alveolus or alveolar cleft, anchylosis, cysts or neoplastic formations, root dilaceration, iatrogenic causes\(^7\), traumas\(^8\) and idiopathic causes. Some authors report genetic\(^9\),\(^10\) or family factors\(^11\). Palatal impaction of the permanent upper canine tooth appears in several generations of one family, and is related to congenital missing teeth or microdontia, especially of the upper lateral incisors\(^12\).

Another factor that affects tooth development is nutrition, as delayed development of tooth buds has been reported in patients with malnutrition and patients with low birth weight, with associated malocclusion\(^13\).

Statistical determination of nutritional levels is based on three indicators: weight-age, which measures overall malnutrition; height-age, which reflects chronic malnutrition because shortness is the result of a lengthy lack of nutrients, and weight-height, which measures acute malnutrition\(^14\). The prevalent type in northern Argentina is height-age deficit. Measurements of dental arches in children chronologically aged 4 to 8 years with different nutritional states were significantly larger in females with normal nutritional state than in females with chronic malnutrition; no difference was found among males\(^15\).

Tooth embryology and formation is a continuous process of development that runs from the sixth week of prenatal life to about 20 years of age. Of all teeth, the permanent upper canine has the longest development period; it emigrates from the side of the pyriform fossa to its final destination in the occlusion position\(^16\). During the course of its development, the crown is closely related to the root of the upper lateral incisor, and it has been determined statistically that there is a relationship between palatal displacement of the permanent upper canine tooth and absence or reduction in crown width of the adjacent lateral canine tooth\(^17\).

Different methods, all of which provide similar results, can be used to estimate dental age according to the radiographically observed degree of development of the permanent tooth buds\(^18\). In this study we used the method proposed by Haavikko, 1974, which was obtained from Scandinavian populations\(^19\), because there are no original tables for tooth development in the population of northern Argentina.

The radiographic factors that influence orthodontic decisions to expose or remove an impacted upper canine tooth have been evaluated. These factors are palatal position of the crown and angling towards the mid-line\(^20\). Some researchers suggest parallel studies, where the horizontal angling is altered enabling determination of the position of the canine impacted in the occlusal plane towards the vestibu lar or palatal location. In images this is seen as a displacement of the canine towards mesial or distal positions. The combination of periapical studies with occlusal studies has also been mentioned\(^21\).

During clinical practice, the first radiograph is often a panoramic radiograph, in which the image of the impacted canine teeth in palatal position is magnified with respect to canine teeth located in normal position. Computed tomography is the most sensitive, specific method\(^22\),\(^23\). Other authors, using profile teleradiography, found that ectopic canine teeth are displaced further forward than normal teeth\(^24\).

Because of the multiple consequences of impacted canine teeth, such as external root resorption of neighboring teeth, mainly the upper lateral incisors\(^25\), crown resorption\(^26\) and the fact that they may turn into dentigerous cysts\(^27\), early diagnosis of this kind of anomaly is important.

The aim of this study was to establish associations between certain radiographic variables related to the upper canine tooth buds and the nutritional state of a population of schoolchildren in northern Argentina.

**MATERIALS AND METHODS**

The study included 33 children of chronological ages 3 to 9 years from a population of rural schoolchildren in Tucumán. Height and weight were recorded using precision scales with a height rod,
which was calibrated prior to the start of the study. The operator underwent theoretical and practical training in nutritional anthropometry according to the recommendations of the World Health Organization. Chronological ages were obtained by checking school records. Parents were asked for informed consent.

According to the height-age and weight-age values assigned in the Argentine Pediatrics Association guidelines for assessment of growth, the children were classified into 3 nutritional groups: a) Malnourished: values beneath percentile 25; b) Normal: values between percentiles 25 and 75; c) Overweight: values above percentile 75 (Lejarraga and Orfila, 1987).

Radiographic examination: A systematized radiographic technique was applied to both the right and the left permanent upper canine teeth sides. Wheeled 70kV DSJ 8 mA X-ray equipment and Insight Nº 2 intraoral film (E F speed; Eastman, Kodak, Rochester, NY) were used. The following procedure was applied: a) Head position: obtained when the Frankfurt plane that goes from the wing of the nose to the tragus (lateral view) and the bipupilar plane (front view) are parallel to the ground (Fig. 1). b) Position of the film: parallel to the occlusal plane, held in place by bite pressure, so that the greater axis is parallel to the intermaxillary suture going beyond the mid-line, while the shorter edge of the film, located in anterior position, should go beyond the incisor edges of the upper central incisors by 1 mm, in parallel form. c) Direction of the central ray: in antero-posterior direction; the ray must be directed with a vertical angulation of 70º with respect to the plane of the film, and must be parallel to the mid-line, i.e. 0º horizontal angulation is applied, with a point of incidence at the level of the canine fossa (Fig. 2).

d) Mean exposure time: 0.40 seconds. Radiographic material was processed manually, and patients received all the adequate radio-protection measures (law 17557).

The 66 radiographic studies obtained were digitalized with a scanner (Genius, Color Page-HR3), and the Image Tool for Windows 3.00 was used to measure the following variables: a) distance from the upper canine cusp to the intermaxillary suture, expressed in mm (Fig. 3); b) external angle formed between the axis of the upper canine tooth bud and the perpendicular plane that cuts the intermaxillary suture (Fig. 4), expressed in degrees (º); c) calculation of dental age was determined by means of observation of the degree

![Fig. 1: Front view of the application of the systematized special technique.](image1)

![Fig. 2: Vertical angulation with respect to the horizontal plane. Profile view of the systematized special technique.](image2)

![Fig. 3: Measurement of the distance from the canine cusp to the middle raphe in a digitized radiographic image.](image3)

![Fig. 4: Measurement of the external angle formed between the axis of the upper canine tooth bud and the perpendicular plane that cuts the intermaxillary suture.](image4)
of calcification of the buds of the upper canine teeth in the radiographic images, according to Haavikko, 1974. This method divides tooth development into 11 phases, 5 of which correspond to crown development, and 6 to root phases: Crypt or absence of calcification (0), initial calcification (C1), half crown development (Cr ½), three quarters crown development (Cr ¾), complete crown development (Cr), initial root formation (R), quarter root length (R ¼), half root length (R ½), three quarters root length (R ¾), full root length (Rc) and closed apex (Ac).

Statistical analysis: The statistical analysis was done with the software SPSS version 11 (SPSS Inc., IL, USA) using the normal distribution tests (Kolmogorov-Smirnov and Shapiro-Wilk). In order to determine whether there are differences between the external angle and distance variables with respect to the nutritional states, Kruskal-Wallis tests and Dunn multiple comparison tests were used.

RESULTS
Regarding the three nutritional groups, it was found from the height-age and weight-age records that 15.1% of the children (n=10) were malnourished, 72.8% (n=48) were normal and 12.1% (n=8) were overweight (Table 1).

In the 66 radiographic studies conducted, the distance and angle variables for the three nutritional groups did not have a normal distribution (Fig. 5a and b, Table 2). For the distance variable, there were significant differences between the normal and overweight groups (p<0.05), but not so between the normal and malnourished groups (p>0.05). The angle variable showed no statistically significant differences among the three nutritional groups (p>0.05). Regarding the analysis of degree of calcification of permanent upper canine tooth buds, Table 3 shows the values for the children’s chronological age and age according to Haavikko, 1974, and the statistics obtained for the three nutritional groups. The analysis of dental age, obtained according to the degree of canine calcification in relation to chronological age, the malnourished and overweight groups (paired T test) showed significant differences (p<0.05). The age of the normal group with respect to Haavikko, 1974, showed no significant difference (p>0.05) (Table 4).
Table 2: Normality test for the variables angle and distance according to nutritional state

<table>
<thead>
<tr>
<th>Nutritional State</th>
<th>Kolmogorov-Smirnov&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Shapiro-Wilk&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistical</td>
<td>gl</td>
</tr>
<tr>
<td>ANGLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malnourished</td>
<td>.196</td>
<td>10</td>
</tr>
<tr>
<td>Normal</td>
<td>.214</td>
<td>48</td>
</tr>
<tr>
<td>Overweight</td>
<td>.293</td>
<td>08</td>
</tr>
<tr>
<td>DISTANCE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malnourished</td>
<td>.198</td>
<td>10</td>
</tr>
<tr>
<td>Normal</td>
<td>.116</td>
<td>48</td>
</tr>
<tr>
<td>Overweight</td>
<td>.208</td>
<td>08</td>
</tr>
</tbody>
</table>

<sup>a</sup> This is a lower limit than true significance.
<sup>a</sup> Correction of the Lilliefors significance

DISCUSSION

Tucumán Province has one of the highest rates of child malnutrition (30%)<sup>28</sup>. These values do not include overweight children, whose condition is often the result of poor quality nutrition made up mainly of low-cost food containing many calories and low nutritional value.

This study involves the odontological and radiographic clinical analysis of parameters which allow alterations in the speed of development of tooth buds to be detected and could contribute to early detection of a potential impacted upper canine tooth. Radiographically measured variables are identified which enable the detection of alterations in the speed of development of the upper tooth buds. These alterations are also associated to children’s nutritional state.

Some authors believe that the best age for early diagnosis of future impacted upper canine teeth is from 8

Table 3: Statistics of chronological age for each nutritional state and age calculated using de Haavikko, 1974 tables

<table>
<thead>
<tr>
<th>Pair</th>
<th>Haavikko age</th>
<th>Chronological age malnourished</th>
<th>Mean</th>
<th>N</th>
<th>Typ. deviation</th>
<th>Typ. error for mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.125</td>
<td>6.250</td>
<td>4.25</td>
<td>4</td>
<td>2.46086</td>
<td>1.23043</td>
</tr>
<tr>
<td>2</td>
<td>6.5455</td>
<td>6.6045</td>
<td>2.05</td>
<td>22</td>
<td>1.56532</td>
<td>.33373</td>
</tr>
<tr>
<td>3</td>
<td>5.7500</td>
<td>6.4875</td>
<td>-3.20</td>
<td>8</td>
<td>2.43487</td>
<td>.77285</td>
</tr>
</tbody>
</table>

Table 4: T-test for related samples of the pairs formed between age of the nutritional groups and age calculated using Haavikko (1974) tables, according to degree of calcification of the permanent canine

<table>
<thead>
<tr>
<th>Pair</th>
<th>Haavikko - malnourished</th>
<th>Haavikko - normal</th>
<th>Haavikko - overweight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-1.1250</td>
<td>-1.6819</td>
<td>-1.2269</td>
</tr>
<tr>
<td>2</td>
<td>-.0591</td>
<td>-.3457</td>
<td>-.429</td>
</tr>
<tr>
<td>3</td>
<td>-.7375</td>
<td>-.2481</td>
<td>-3.563</td>
</tr>
</tbody>
</table>

to 10 years because at that age the canine tooth still has its eruptive potential. That would allow its position to be corrected by means of orthodontic treatment without traumatic procedures such as surgical exposure and traction. The removal of the temporary canine tooth is also suggested for patients whose arches do not lack space, in order to avoid potential impaction. Aesthetic and functional disorders, and even lateral incisor resorption, are thus avoided.

The study of dental calcification is considered to be the best method for determining a patient’s biological age. Many methods have been developed to determine the degree of calcification of the permanent tooth buds based on radiographic images, some of which require the information of a quadrant, while others, such as Haavikko, 1974, and Nolla, 1960, suggest using a tooth or small group of teeth, thus reducing the time and cost involved in the study, which in turn enables dental age to be determined in cases where information on the whole quadrant is unavailable. This is why the Haavikko, 1974, method was chosen for this study, as well as because it has proved to be an effective estimator of chronological age in children of both genders under 10 years of age.

Since Tucumán Province has not published its own tables for standard weight and height for girls and boys, this study used as a reference the tables drawn up from populations in Buenos Aires and Córdoba Provinces and La Plata city, Argentina, to calculate the normal nutritional state of the population. The application of a systematized radiographic technique prevents factors not dependent on the clinical case from altering the values of the variables. As conventional radiographic equipment and standard film are used, the technique is inexpensive and can be applied by a dentist general practitioner. This study showed that both the distance of the upper canine tooth bud and its degree of calcification vary in patients with nutritional disorders, so it would be useful to conduct a systematic radiographic study at school age in order to detect anomalies in dental development and thus reduce their possible consequences.

ACKNOWLEDGMENTS

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REFERENCES


