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Theoretical approach to the cephalometric diagnosis of third molar eruption

Aproximación teórica al diagnóstico cefalométrico de la erupción de terceros molares

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ABSTRACT

The cephalometric diagnosis of third molars, as the molar group that heads the list of dental retentions, has been very variable and controversial from the clinical to the most modern radiographic methods. A literature review was carried out from January 2017 to March 2020; consulting articles, theses and texts available in databases; enlisting a total of 33 bibliographical references from which 27 were selected. The selection criteria were the direct relation with the subject, updating level in the last 5 years, as well as their methodological quality. The objective was aimed at describing the theoretical approaches to cephalometric diagnosis of third molar eruption. The review showed that there is a wide variety of studies on cephalometric diagnosis of third molar eruption with different limitations, each one contributing with their own approach to the subject, with isolated aspects on the etiology of the abnormal eruption in foreign contexts, offering measures that do not adjust to the Cuban population, representing 72.2 % in the last 5 years, including texts, not so updated, but which were of essential consultation due to the importance of their contents. It was concluded that the theoretical approaches

presented by the literature on cephalometric diagnosis of third molar eruption are distinguished by the use of different foreign methods in diverse populations; highlighting a Cuban method applicable to the local and national context.

Key words: third molar, wisdom tooth, cephalometric diagnosis, Orthodontics.

RESUMEN

El diagnóstico cefalométrico de los terceros molares, como grupo molar que encabeza la lista de retenciones dentales, ha sido muy variable y controvertido desde la parte clínica hasta los métodos radiográficos más modernos. Se realizó una revisión bibliográfica desde enero de 2017 hasta marzo de 2020; y se consultaron artículos, tesis y textos disponibles en bases de datos. Se copiló un total de 33 referencias bibliográficas y de ellas se seleccionaron 27. Los criterios de selección fueron la relación directa con el tema, nivel de actualización en los últimos 5 años, así como su calidad metodológica. El objetivo fue describir las aproximaciones teóricas al diagnóstico cefalométrico de la erupción de terceros molares. La revisión demostró que existe una gran variedad de estudios sobre el diagnóstico cefalométrico de la erupción de terceros molares con diferentes limitaciones, que aportan su propio enfoque al tema, con aspectos aislados sobre la etiología de la erupción anormal en contextos extranjeros, y de este modo ofrecen medidas que no se ajustan a la población cubana, con un 72,2 % en los últimos 5 años, incluyendo textos, no tan actualizados, pero que fueron de imprescindible consulta por la importancia de sus contenidos. Se concluyó que los enfoques teóricos que presenta la literatura sobre el diagnóstico cefalométrico de la erupción de los terceros molares se distinguen por la utilización de diferentes métodos foráneos en diversas poblaciones; y se destaca un método cubano aplicable al contexto local y nacional.

Palabras clave: tercer molar, muela del juicio, diagnóstico cefalométrico, Ortodoncia.

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Introduction

Diagnostic procedures vary constantly with progress, but dentofacial anomalies are always the same. From this perspective, Mayoral quoted by Gonzalez Espangler⁽¹⁾ summarizes that the clinical orthodontic diagnosis comprises two clearly delimited phases: the first, analysis of the anomalies presented by the patient, taking into account the place where they are located and their nature (differential diagnosis); of their causes and mode of action (causal and morphopathogenic diagnosis) and of patient's individual conditions (individual diagnosis); and the second, of synthesis of the data collected in the first phase, which is the one that characterizes the clinical case, the real diagnosis.

In reference to third molars as the molar group that heads the list of dental retentions, ^(2,3,4) this procedure has been very variable and controversial from the clinical to the most modern radiographic methods. The selection of a prophylactic conduct to be followed, will depend on the diagnosis, based mainly on the study of the causal agents associated with the eruption anomalies of these teeth. ^(5,6,7)

Being able to predict the possibility of correct eruption of third molars has been a constant concern, because there are many myths, stories and beliefs about this subject, which makes the relationship with patients complicated when dealing with this issue. Some researches mention that it is difficult to predict with certainty the biological aspect; but if a correct analysis is made, it is possible to know with certain probability the eruption or retention that this dental group could present.

From the orthodontic point of view, early detection and extraction of third molars are advisable processes, because they guarantee stability in the treatments, as well as avoid undesired movements due to their mesial thrust force during their eruptive process and damage to the neighboring teeth and tissues when they do not have enough space.

The truth is that the orthodontist needs to rely on the observation of the clinical and radiographic characteristics, supported by cephalometric analysis of dental and facial structures, which is little used in daily practice when dealing with third molars, since it is usual to plan as one of the objectives of treatment, the rupture of

the anterior component of the forces through surgical excision, taking into account only the clinical experience when there is bone-tooth discrepancy.

The pathological course of these molars, their incidence on oral health and their social implication constitute a transcendental ancient subject and at the same time a paradoxical contemporary controversy. On the other hand, their surgical extraction is the most common procedure performed in oral surgery, being one of the main indications in early ages, orthodontics.⁽¹⁻⁵⁾

It is known that throughout history there have been several proposals applied to anticipate the negative consequences related to these teeth, among which stand out those of Hellman, Broadnet, Björk, Ricketts, Turley, Richardson, Turley and Tatsuno, mentioned by González and collaborators,⁽⁸⁾ most of them based on imaging studies in profile telerradiographies and on mandibular third molars; with values that cannot be adjusted to a Cuban population.

Although there are not many authors dealing with this subject in Cuba, there are some authors such as Céspedes and Carbonell⁽⁹⁾ and Fernández and collaborators⁽¹⁰⁾ in Havana and the work team of Pérez Cabrera in Granma,^(11,12) who have made evaluations in panoramic radiographs, they have used and established comparisons with different measurement methods, as well as reached conclusions that differ from those obtained in other countries.

Based on the above-mentioned background, which highlights the contradictions, and inconsistencies in relation to the subject, the present review aims at describing the theoretical approaches to the cephalometric diagnosis of third molar eruption.

Methods

A literature review was conducted during the period from January, 2017 to March, 2020, for which articles, theses and texts available in remote databases were consulted: MEDLINE, EBSCO, HINARI, COCHRANE, PUBMED, browsers such as Google Scholar, as well as data from the Latin American Health Sciences Information Network: LILACS, REPIDISCA, ADOLEC, LEYES, SeCS and websites. The most important national literature databases were also accessed: CUMED, SACU and SeCiMed. An important variety of orthodontic specialty texts were also

consulted, where aspects related to cephalometric diagnosis of third molars are addressed.

As a strategy for the search, descriptors such as cordal, third molar, cephalometric diagnosis, orthodontics were used; applying the initial review of primary sources of information such as original publications of scientific studies and recent information. Subsequently, secondary sources such as the aforementioned databases where compilations, abstracts in journals and lists of published references were found and finally, tertiary sources included textbooks on third molars and some on orthodontics.

A total of 33 bibliographic references were consulted and of these, 27 were selected for the research, based on criteria such as: direct relationship with the topic in question, level of updating in the last 5 years for original and review articles and up to 10 years for books and other printed texts; as well as their methodological quality.

Development

Description of the theoretical approaches to cephalometric diagnosis of third molar eruption

Orthodontics, as a dental specialty, is a morphological science. Therefore, it is justified to use morphometric methods to analyze a malocclusion, and cephalometry is a technique that allows the measurement of the skull, face, jaws and dental position. ^(1,13) To understand the objectives and assess its possibilities, it is appropriate to recall initially the origin and course of cephalometry and its link with other morphological sciences.

Anthropometry as a descriptive science of man has been defined by Hrdlicka quoted by Rodríguez-del-Toro and contributors⁽¹⁴⁾ as that which deals with observing and measuring man, his skeleton and other organs, by reliable means and with scientific objectives. This science studies the human morphological pattern, and has always been interested in cranial, facial and dental measurements. To facilitate its communication, osteometry emerged, which is a descriptive science that allows the objective quantification of any human bone and the

application of the scientific method to the study of the morphological features of man.^(1,14,15) The possibility of measuring the living being, somatometry, expands the applications of physical anthropology and constitutes a science of particular importance for analyzing the evolutionary changes of man and the differences between races or geographical areas. Craniometry derives from osteometry; and cephalometry from somatometry, which encompasses the morphological study of all the hard and soft structures present in the human head.

When radiographic techniques are applied to the analysis of the human head, radiographic cephalometry emerges,^(16,17,18) which is applied to living man during the active growing period to study and analyze the complex process of maxillofacial development.

The first cephalometric analyses recorded in the literature appear in 1922, when Paccini's works on cephalometry were published, cited by Companioni Bachá and collaborators,⁽¹⁹⁾ who was the first in adapting and modifying existing anthropometric techniques in radiographs taken from dried skulls and living beings. This fact marks the first turning point in the historical evolution of cephalometric diagnosis.

Since the origin of current cephalometric diagnoses is closely related to anthropological studies performed on dried skulls, measurements were also performed on the maxilla, mandible and third molars on these anatomical structures.

There are several methods described in the literature that have studied the possibility of eruption of these teeth; initially, the measurements made on dry skulls and nowadays the sophisticated cephalometric tracings stand out.

The latter reports mathematically the positions and dentomaxillofacial relations, giving a result of invaluable importance for a particular orthodontic or orthopedic treatment, which together with the image quality obtained with the current teleradiographic equipment, allows to have an undisputed diagnostic document in Orthodontics.⁽¹⁾

In this context, cephalometric research on third molars can be grouped according to the measurement of three local etiological aspects that influence tooth eruption: posterior bone space, angulation and mesiodistal diameter.

I. Posterior bone space:

Measurements of these spaces are the most abundant in the literature, which has given a leading role to this etiological factor in the eruption of third molars, based on the fact that for a tooth to erupt normally it needs sufficient space for this. Different methods have been described, some cited by Quiros and Palma,⁽¹³⁾ as well as by other authors,⁽⁸⁻¹¹⁾ among which the following stand out:

- Henry and Morant, who in 1936, proposed the molar space index, which is expressed by the mesiodistal width of the lower third molar and the percentage of space between the anterior border of the ramus and the second molar.
- Björk in 1956, measured on cephalic radiographs the distance from the anterior border of the ramus to the distal surface of the lower second molar and suggested that the probability of retention decreases as this distance increases.
- Ricketts in 1972, confirmed Björk's observation by evaluating approximately 100 skulls and argued that the probability of a successful eruption was directly related to the portion of the lower third molar that extended beyond the anterior border of the ramus; but if half of this tooth was located behind the ramus, that probability was 50 %.
- Two years later, in 1974, Turley evaluated different methods of measuring the available space and concluded that the most useful was the one that measured the distance from Xi (center of the ramus) to the distal face of the second molar. The average distances proposed by this author were: 21 mm for impacted molars, 25 mm for erupted but out-of-position molars and 30 mm for molars in occlusion. He also stated that the prediction can be made from 8 to 9 years of age with 90 % accuracy and that the length from the pterygomaxillary fossa (PTM) to the upper second molar should measure more than 25.7 mm in males and more than 22.8 mm in females.
- Ricketts (1976) quoted by Ordoñez,⁽²⁰⁾ pointed out that a distance of 30 mm was sufficient for the eruption of the third molar and another of 20 mm or less was insufficient, with an error of 2.8 mm; at the same time he

supported Turley's statement that predictions can be made from 8 to 9 years of age. Regarding the upper molars, he thought that taking into account the position of the upper molar, the distance from the distal face of the upper first molar to the pterygoid vertical (PTV), measured perpendicular to the latter, could be calculated, taking as a norm the patient's age plus 3 mm with a standard deviation (SD) of 3 mm; but if this space was smaller, it would be impossible for the upper third molar to erupt.

- Céspedes and collaborators in 2000, used Turley's method in Havana, Cuba, taking his values as a reference, although the results obtained by this author refer to another population and geographic region, which is undoubtedly an influential factor.
- In 2012, Pérez Cabrera and collaborators used the method previously mentioned in children aged 10 to 13 years, in the eastern region, specifically in Granma, in whom it was predicted which molars could erupt or be retained according to the measures proposed by this author.
- Three years later, in 2015, Fernandez and collaborators, in Havana city, analyzed the space available for the eruption of mandibular third molars in individuals from 11 to 20 years of age, in profile and panoramic radiographs and performed manual and digital measurements with the retromolar index, which classifies retention as probable and very probable.
- In 2017, Perez Cabrera et al⁽¹²⁾ return with the measurement of mandibular body length and possible eruption of third molars according to the average measurements published in their previous study, with the same number of patients and reported the finding of retained mandibular third molars with normal mandibular body length.
- In 2019, González and collaborators⁽²¹⁾ in Santiago de Cuba, published a study in school children with the purpose of estimating the magnitude of the changes in the posterior bone space according to age in childhood (8-10 years of age) and adolescence (15-18 years of age). A novel method was used in this study: that of Gonzalez Espangler,⁽²¹⁾ who used the first permanent molar as a reference for the measurements.

- In 2020, González with another research team⁽⁸⁾ and with the same measurement method proposed average measurements of posterior space in adolescents between 15-18 years of age. The values were 19.9 mm for the right upper space; 20.0 mm for the left and for the lower ones 40.7 and 42.3 mm for the right and left spaces respectively. Subsequently, they identified the magnitude of changes in this space in a 3-year interval and showed that the variations were statistically significant; an increase of 3.9 mm was observed for the right superior and 3.8 mm for the left superior spaces; 3.0 mm for the right inferior and 3.3 mm for the left inferior spaces.

II. Angulation:

This factor, although very little addressed, has been of interest to some, especially in the lower molars. The various researchers have assessed that the inclination of the third molars with respect to their bony bases, which is very inclined when the age at which they should erupt approaches, prevents them from erupting correctly, especially due to the influence of the eruption trajectory, which depends to a great extent on the retromolar space and the size of the dental crown. Therefore, some of them are mentioned below:^(1,6,13,14)

- In 1974, Richardson stated that small values in the initial mesial inclination angles of the lower third molars favor eruption, while most of the impacted ones have had little straightening and their degrees of angulation are increased.
- In 1976, Bjork and Rikkets stated that the angulation of the lower third molar should not be less than 40°, as it increases the possibility of retention. They do not recommend making predictions before 13 or 14 years of age, due to the difficulty of measuring with certainty the necessary distances and determining the real angulation of the third molar with respect to its apical base, which would make the measurement very subjective.
- In 1977, Richardson concluded in his studies that the original angulation of the occlusal surface of the lower third molar in relation to the mandibular

plane is significantly lower in those persons in whom this tooth has erupted early, but that this value is not predictive.

- Hattab and Alhaija, without specifying the year, explained the influence of the angulation of the lower third molars on the process of their non-eruption, took measurements on panoramic radiographs and stated that the more acute angles (mesioangulations) with a tendency to horizontalization, associated with small retromolar spaces, favored eruption in a bad position and retention.
- In 1997, Quirós and Palma concluded in their analysis of a predictive method of eruption that one of the factors that intervene in the retention of these teeth is the direction of eruption measured through the angle they form with their bony base, whose value was 38° in those that appeared in the oral cavity, with an inclination of less than 40° in all the molars that were able to emerge without difficulty.
- In 2005, Martínez Martínez and collaborators stated that the factors that most commonly generate lower retention are the size of the retained third molar, which exceeds the space they have available for eruption; the angulation of the molar, most of which presents mesioangulations, preventing it from erupting completely and the lack of mandibular development, small arches and insufficient spaces that make the eruption of the third molars impossible.
- In 2018, Morales and Riquelme, (6) found differences in mandibular shape and gonial angle between people with impacted and erupted molars, and they also found that a sharper gonial angle and smaller mandible were common in those with impacted molars, and there was greater angulation of the third molar with respect to the mandibular plane.
- In 2019, González Espangler in Santiago teenagers, proposed average angulation measurements of the four third molars in panoramic radiographs, according to her own method, taking into account the inclination of the longitudinal axis of the molar with respect to the mandibular and spinal planes. The values were 129.2° ; 124.2° ; 63.6° and 62.9° for upper and lower, right and left angulations respectively.

III. Mesiodistal diameter:

In relation to the mesiodistal diameter of these teeth there are also several criteria, since the anatomy of the third molars has been described as unpredictable as it presents greater variation than any other tooth of the oral cavity.⁽¹⁶⁾ Among these, the following stand out:

- Hollinshead, as well as Sicher and Dubrul, in 1983 and 1991 respectively, cited by Fuentes and collaborators,⁽²²⁾ argue that the upper molars should have a mesiodistal diameter of 8.5 mm and the lower ones of 10 mm; with measurements taken in profile teleradiographs.
- Quirós and Palma⁽¹³⁾ in 1997, obtained measurements of 12.9 mm for the lower molars in profile teleradiographies, while in panoramic ones these distances were 15.7 mm for the right molar and 15.8 mm for the left molar.
- Figún and Garino, Ash and Nelson mentioned by Fuentes and collaborators⁽²²⁾ point out in profile teleradiographies that the maxillary molars present a mesiodistal diameter of 8.5 mm and the mandibular ones of 10; while others such as the latter researchers report figures of 9.4 and 11.8 mm for upper and lower mesiodistal distances, respectively.
- Companioni and Bachá in 2012, cited by González Espangler,⁽²³⁾ performed direct measurements and claim that the maxillary third molar is the smallest of the molar series and that the mandibular ones are more variable, since sometimes they can be the smallest and sometimes the largest, with mesiodistal diameters of 9 mm for the former and 10.5 mm for the latter.

After analyzing the course of the diagnosis of three of the local etiological factors that most influence the eruption of third molars, the following difficulties were detected:

- Most of the researchers used profile teleradiography, which is not very accurate in discriminating the four sides of the patient to measure the

space, angulation and mesiodistal diameter of the third molars, due to the superimposition of images.

- There are few studies on panoramic radiographs, which also only refer to the aforementioned characteristics of the lower third molars.
- The measurements proposed by Turley more than 40 years ago in the posterior osseous space are used as a reference; as well as the angulation obtained in other population different from the Cuban one; therefore, the studies carried out in Cuba have reached conclusions that differ from those obtained in other countries. Regarding the mesiodistal diameter of these teeth, no average measurements were found on panoramic radiographs.
- In addition, the samples were small, in some cases the patients were not observed over time and all those included received orthodontic treatment, which could modify and falsify the results of the measurements.
- The ages of those included in the studies were generally lower than those of the third molar eruption and no other causal factors were considered for the diagnosis, except for the posterior bone space.
- Finally, none of the authors reviewed conducted a causality study to determine the predictive factors of abnormal eruption, taking into account these three aetiological aspects mentioned above.

Considering that nowadays the use of models has become generalized as an auxiliary system to penetrate into the essence of phenomena linked to all spheres of human cognitive and transforming activity; and that in the field of biomedical research, its use is more frequent, as an indispensable instrument to transform practice and enrich its theoretical support,⁽²⁴⁾ González Espangler⁽¹⁾ decided to go deeper into this subject and designed a cephalometric model that included variables associated to the abnormal eruption.

The predictive cephalometric model proposed by González Espangler⁽¹⁾ was based on the review of the specialized literature on the subject. Thus, while some authors^(6,7,9,10) consider that the posterior bone space constitutes the main local risk factor, others such as Marroquin Ramirez cited by Ryalat and contributors⁽²⁵⁾ state that it

is the angulation that prevents the normal eruption of third molars; however, there are few reports on the influence of their mesiodistal diameter.

Considering that when the position of the teeth in their arches is analyzed intramaxillary, three different situations can be found:^(26,27) they are well aligned (no discrepancy), diastemas are observed (positive discrepancy) and there is crowding or lack of space for the arrangement of the erupted teeth or not (negative discrepancy), it is essential to evaluate the size of the teeth and their relationship with the space available to be placed in the dental arches.

Regardless of this, it is known that for a tooth to straighten, it needs enough bone space to do so; but it is also known that morphometry is influenced by this variable,⁽²²⁾ which means that with more space the molar should be able to achieve verticality and develop to the genetically determined size. On this basis, it is not possible to classify this factor as protective, as statistically obtained.

Thus, the cephalometric predictive model of González Espangler⁽¹⁾ decided to go deeper into this subject and design a cephalometric model that included these variables associated with abnormal eruption. The model has a scheme where the predictive factor of this condition is represented for each third molar, including the average values related to this effect. A table of individualization of these norms is added for boys and girls from 8 to 10 years of age, since it is at these ages when the possible occurrence of this abnormality can be better predicted.

The individualization was based on the result of a logistic regression that allowed to know how much this space varies from infancy (taking into account that this is where most orthodontic treatments begin), to adolescence, selecting the age of 18 years evolutionarily that represents the post-pubertal period in both sexes (where pubertal growth spurts have occurred ^(1,8) and from the dental point of view, third molars may have erupted). ^(1,17)

For its implementation, the current age of the individual is considered, the posterior bone spaces are measured and what is supposed to increase for each year is added to it; once this information is obtained, it is compared with the information concerning the inadequate posterior bone space and the prediction is made: an abnormal eruption is expected if it is equal to or less than the values established for that quadrant or normal if it exceeds those values.

The validation of this instrument was carried out from the statistical point of view in its initial version, being currently immersed in a validation in individuals for which it was designed, through its partial implementation by the authors of the present bibliographic review.

After analyzing the different studies on the cephalometric diagnosis of third molar eruption, it is assumed that the most comprehensive is that of González Espangler,⁽¹⁾ due to its contextualization at a local and current level; presenting the following advantages:

- From the scientific-practical point of view, it offers a possible preventive solution to the eruption problems associated with third molars for orthodontics, in such a way that it allows early planning, based on scientific evidence, of the conduct to be followed in the emergence of these teeth, avoiding therapeutic recurrence through periodic clinical and radiographic examinations after the patient has been discharged from this dental service.
- It eliminates empiricism based only on clinical experience, because in addition to this the orthodontist will plan as one of the objectives of treatment, the rupture of the anterior component of the forces by surgical excision, taking into account the cephalometric prediction.
- In the predictive context, it allows to apply an early and effective treatment, which avoids discomfort to the patient and allows the development of preventive activities of accidents and complications associated with the abnormal eruption of these teeth.
- Due to early intervention in this process, the proportion of adults with discomfort associated with the abnormal eruption of these teeth and the emergence of pathologies resulting from tooth retention could be reduced, thus increasing the level of satisfaction of the population assisted, mainly children and adolescents, and the quality of dental care.
- Finally, the present research will also contribute to the solution of a health problem included in the Dental Care Program for Children under 19 years of age, interest to the Cuban Ministry of Public Health: dentomaxillofacial anomalies.

The use of models as an auxiliary system to penetrate into the essence of phenomena linked to all spheres of human cognitive and transforming activity has become widespread. In the field of biomedical research, its use is increasingly frequent, as an indispensable instrument to transform practice and enrich its theoretical basis. ⁽¹⁸⁾

Limitations of the study:

the research is limited by the fact that it only includes a theoretical analysis, from a cephalometric perspective, of the three most important local factors that influence the abnormal eruption of third molars, although others could be included.

Conclusions

The theoretical approaches presented in the literature on cephalometric diagnosis of third molar eruption are distinguished by the use of different foreign methods in different populations, highlighting a Cuban method applicable to the local and national context.

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Conflicts of interests

The authors declare that they have no conflict of interest.

Authors' contributions

Dr. Mercedes Rodríguez del Toro: Data curation, research, writing the original draft and writing of the article. Participation 50%

Dr.C. Liuba González Espangler: Conceptualization, formal analysis, methodology, visualization, writing the original draft and reviewing of the article. Participation 25 %

Licentiate Cecilia Venzant Fontaine: Translation, writing of the original draft and reviewing of the article. Participation 25 %

