

REVIEW

Baccetti method for assessing bone maturation: analysis from the perspective of science, technology, and society

Método de Baccetti para evaluación de maduración ósea: análisis desde la ciencia, tecnología y sociedad

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ABSTRACT

Introduction: the Baccetti cervicovertebral evaluation method uses the cervical vertebrae to assess bone maturation using lateral cranial telerradiography, which is indicated for all patients attending an orthodontic consultation. This method eliminates the need for additional radiological examinations.

Objective: to describe, from the perspective of science, technology, and society, the impact of the Baccetti method as a tool for orthodontic diagnosis.

Method: a bibliographic review was conducted of journals, books, theses, and original texts available at reference centers such as the Library of the Faculty of Stomatology of Havana and digitally through Google Scholar.

Development: the Baccetti method is effective due to its simplicity and high correlation with other existing methods. Its use also allows for savings in resource planning, a very important aspect of economic and organizational management. Its use avoids the need for additional radiographic studies and increases the effectiveness of scientific research.

Conclusions: the Baccetti method as a diagnostic tool constitutes a social practice that provides the orthodontist with knowledge, skill, and an instrument that improves the quality of patient care, makes it possible to organize resources and distribute them equitably by avoiding unnecessary radiographic studies, with the aim of integrating an individual into society without stable aesthetic and functional impairments over time.

Keywords: Science; Technology and Society; Cervical Vertebrae; Radiology.

RESUMEN

Introducción: el método de evaluación cervicovertebral de Baccetti utiliza las vértebras cervicales para valorar la maduración ósea empleando la telerradiografía lateral de cráneo, la cual es indicada a todos los pacientes que acuden a consulta de Ortodoncia. De esta forma el paciente no tiene necesidad de realizarse exámenes radiológicos adicionales.

Objetivo: describir desde el enfoque de la ciencia, la tecnología y la sociedad el impacto del método de

Baccetti como herramienta para el diagnóstico ortodóncico.

Método: se realizó una revisión bibliográfica en revistas, libros, tesis y textos originales, disponibles en centros de referencias como la Biblioteca de la Facultad de Estomatología de La Habana y por vía digital a través de Google Académico.

Desarrollo: el método de Baccetti resulta eficaz por su simplicidad y alta correlación con otros métodos ya existentes. Su empleo permite además el ahorro durante la planificación de recursos, aspecto muy importante en la gestión económica y organizativa, con su uso se evita indicar estudios radiográficos adicionales e incrementa la eficacia de la investigación científica.

Conclusiones: el método de Baccetti como herramienta para el diagnóstico constituye una práctica social que aporta al ortodoncista conocimientos, destreza y un instrumento que mejora la calidad de atención al paciente, posibilita organizar los recursos y distribuirlos de forma equitativa al evitar los estudios radiográficos innecesarios con la finalidad de integrar a la sociedad un individuo sin afectaciones estéticas y funcionales estables en el tiempo.

Palabras clave: Ciencia; Tecnología y Sociedad; Vértebras Cervicales; Radiología.

INTRODUCTION

Humans live in constant interaction with phenomena and processes that surround them, some of which are known to them and others yet to be discovered. This is the task of science, which seeks to understand the world. Science is done to discover a hidden reality.⁽¹⁾

The function of science, then, is closely tied to the acquisition of knowledge and learning. The function of technology is linked to the realization of procedures and products, with utility as its purpose.⁽²⁾

The process that encompasses this purpose of technology has given rise to the development of technology. This is a reflection of the development of technology, which, when combined with science, introduces a distinguishing feature.⁽²⁾

The evolution of science, technology, and society cannot be explained separately. In principle, societies capable of organizing and communicating had to form first. Technology emerged from the need to improve living conditions, and science evolved from the desire to understand the world.⁽¹⁾

These concepts are crucial in research, so it is essential to comprehend the social aspects of scientific and technological phenomena, their social determinants, and their social and environmental implications, establishing a close relationship between different areas of knowledge.⁽²⁾

Studies in the specialty of orthodontics, as a branch of dental science, have focused much of their research on the growth and development of the individual. Among their lines of research, one of the most important is finding an indicator of maturation that allows them to determine the degree of an organism's development, independent of chronological age, since it has been observed that maturation processes do not always coincide with the child's age. It has been demonstrated that an accurate indicator of these maturation processes can be obtained by evaluating the stages of bone maturation.⁽³⁾

Knowledge of these stages is of great importance in the field of orthodontics and maxillary orthopedics, as it allows the stage of growth and development of the patient to be determined, which is highly beneficial in improving the quality of the proposed treatment when skeletal problems are present and orthopedic measures are therefore required to correct the anomaly during childhood or adolescence. This is because, in other stages of life, when the individual stops growing, the problem can only be solved by orthognathic surgery in severe cases or by masking the anomaly in moderate cases.⁽⁴⁾

The Baccetti cervical vertebral assessment method utilizes the cervical vertebrae as a means of evaluating bone maturation through lateral teleradiography of the skull, which is recommended for all patients visiting an orthodontist. This means that the patient does not require additional radiological examinations.

This method has been studied in foreign populations, making it of great interest to corroborate whether the stages of cervical vertebral maturation described in it also behave in the same way in Cuban children and adolescents.⁽⁵⁾

These populations have very different genotypic characteristics from the Italian Caucasian population, where the method was initially studied, due to Spanish colonialism in Cuba at the time of their arrival and the mixing with other cultures during the colonial period from the 15th to the 19th centuries.

Through this work, we aim to describe, from a scientific, technological, and societal perspective, the impact of the Baccetti method as a tool for orthodontic diagnosis.

METHODS

A literature review was conducted in journals, books, theses, and original texts available in reference

centers such as the Library of the Faculty of Stomatology in Havana and digitally through Google Scholar on the impact of the Baccetti method as a tool for orthodontic diagnosis from the perspective of science, technology, and society, using the keywords: science, technology, society, cervical vertebrae, and radiology. The search focused on articles published mainly in the last five years, without distinction of language. Thirty articles were obtained and screened to retain only those that explained the relationship between science, technology, and society with the aforementioned diagnostic tool and its impact on orthodontic diagnosis. In this way, 17 articles were selected. The MEDLINE, PubMed, and SciELO reference databases were consulted.

DEVELOPMENT

Orthodontics is the branch of stomatology that deals not only with tooth alignment but also with the correct balance between the maxilla and mandible, as well as the muscles that support the masticatory system. It is responsible for the prevention, diagnosis, and treatment of dento-maxillofacial anomalies for aesthetic and functional purposes.⁽⁷⁾

When the patient presents an imbalance between these bone bases, early correction becomes imperative, as skeletal harmony can only be achieved while the patient is still growing. The more immature the sutures are, the more stable the treatment results will be.

Based on this analysis, it is easy to understand the importance of knowing when the peak of growth is occurring or if it has already occurred, since from this point on, bone maturation is greater and limits or prevents the modification of sutures to correct skeletal problems in the craniofacial complex.⁽⁵⁾

The pubertal growth stage is the most suitable time to initiate orthodontic treatment and should therefore be taken into consideration when planning treatment. In cases where skeletal alterations are present during adolescence, one of the objectives of treatment is to capitalize on the patient's growth changes.^(3,4,5)

These pubertal changes vary among individuals of the same age, and not everyone matures at the same time or the same rate. As a result, chronological age cannot be used to assess pubertal growth. For this reason, it is necessary to assess the biological age of each individual, which is calculated based on bone, dental, morphological, and sexual age.

Determining bone maturation is the most accurate method for assessing the biological age of individuals and clarifying their physiological maturity. Among these, those obtained from X-rays of the carpus and index finger of the left hand stand out, requiring additional X-rays beyond those conventionally used in orthodontic diagnosis.⁽⁴⁾

The current trend in medical and dental sciences is to reduce the number of X-rays to those strictly necessary. Therefore, based on Lamparski's studies, Baccetti developed a method for assessing skeletal maturation using the cervical vertebrae C2, C3, and C4, which routinely appear in teleradiographs taken when patients enter orthodontic consultation.⁽⁵⁾

Baccetti's method was first conceived and validated in the Italian Caucasian population, which has very different genotypic and therefore phenotypic characteristics from the Cuban population.

The characteristics of the population reported in the Baccetti method vary according to their settlement. In the north, Alpine and Nordic features predominate, so they tend to have fair skin, blue or green eyes, and blonde to brown hair. In the center and south, Mediterranean features predominate. In these regions, the skin is darker, with brown eyes and hair, and the complexion tends to be darker.

In general, DNA studies show a genetic influence marked by mixing with Greeks, Balkan peoples, and peoples from the East.⁽⁸⁾

The ethnic composition of the Cuban population is marked by the mixing of Spaniards and Africans as the majority groups, with the influence of small indigenous settlements and Chinese settlers, among others, who arrived on the island in search of a better life in past centuries.⁽⁶⁾

Science has shown that, due to ethnic differences, this method must be adjusted to the characteristics of the population in which it is to be applied. This method requires adjustments for non-Caucasian populations due to differences in bone maturation rates linked to genetic, environmental, and nutritional factors.⁽⁹⁾

Its use is beneficial in orthodontic diagnosis, making it more accurate and easier to perform. It also allows more transparent and more objective goals to be set, which leads to its high significance in treatment planning and outcome, as well as in the selection of the retention method. The technique used to correct the patient's skeletal anomalies, including the application of extraoral traction forces, functional appliances, fixed appliances without extractions, and orthognathic surgery, is based on these growth considerations.⁽⁴⁾

Using the Baccetti method also enables savings during resource planning, a vital aspect in both economic and organizational management. As mentioned above, its use avoids the need for additional radiographic studies, which would generate additional expenses.^(9,10)

This analysis highlights other aspects of the importance of introducing this method, namely that it eliminates the additional radiation to which the patient is exposed when multiple radiographic techniques are required to complete the diagnosis, which has a cumulative effect over time and is detrimental to the health of growing

children and young people.⁽¹¹⁾

Another aspect is that it avoids additional inconvenience to the patient and their family members or guardians, as they would not have to travel to a hospital to undergo another test, such as a carpal X-ray, which would mean missing another day of school and work, if applicable, and failing to complete planned tasks, with the associated work and personal conflicts. It would also be challenging to travel to other institutions, as the means of transport are not always available, or the distance makes access difficult.

Thus, the Baccetti method has become the first-line method of choice for assessing bone maturation in orthodontic patients, proving to be an effective tool due to its simplicity and high correlation with other existing methods.⁽⁹⁾

The conception of this method and its evolution from Lamparski to Baccetti, as envisioned by different researchers over time, reflects the precepts by which the science of orthodontics has evolved.⁽²⁾

The Baccetti method contributes to scientific research by enabling the development of an objective evaluation system. It introduces a six-stage classification system based on specific morphological changes in the C2, C3, and C4 cervical vertebrae, which in turn promotes greater reproducibility in longitudinal studies on craniofacial growth, facilitates comparisons between research carried out in different centers, and validates stages through histological and longitudinal studies. Numerous studies can be conducted using the Baccetti method to investigate the relationship between bone maturation and mandibular growth, growth patterns in different ethnic groups, and the correlation between bone maturation and dental development. The method provides the basis for the development of artificial intelligence systems for automatic evaluation, as well as research on 3D evaluation of vertebral growth and comparative studies with other evaluation methods.

During the 1970s, when Lamparski presented his method for assessing bone maturation based on lateral skull X-rays using analog technology, significant discoveries were made in the fields of radiology and information technology, marking a turning point in the field of medicine. This was the beginning of the transition from analog to digital technology.

By 2005, when Baccetti presented his modifications to Lamparski's proposal and made his contribution to this field, still using analog radiography, two technologies had been introduced in the radiological sciences since the end of the last century: computed radiography and direct digital radiography.⁽¹²⁾

These new technologies would optimize the Baccetti Method, as the integration of digital radiography improved the accuracy of cervical vertebrae analysis, providing greater clarity and facilitating image interpretation. The use of automated software to measure bone parameters, such as the area and perimeter of the vertebrae, allowed for faster and more objective evaluation.^(13,14,15)

Technological innovations have influenced the Baccetti method, transforming it into a faster, more accurate, and more accessible procedure. However, these advances need to be validated to ensure their reliability across different populations, presenting a new challenge for science.⁽¹⁶⁾

Digital diagnostics not only impact the quality of the diagnosis but also the professional's work and their preparation to integrate and apply the changes.⁽¹⁷⁾

In this complex process, orthodontic specialists have had to develop skills and foster abilities to manage these new technologies, as this is not solely the responsibility of the radiologist. The manipulation and interpretation of images, as well as the application of software and AI, are carried out by the orthodontist, who has therefore had to increase their level of specialization and delve into other fields of knowledge. This has resulted in a better-prepared professional entering society, capable of organizing and modifying existing knowledge and increasing the effectiveness of academia and scientific research. The previous point is fundamental to understanding science and its place in society and culture.

The political and social consequences of people's access to diagnostic tools and dental services are an example of the social impact of technology on lifestyles, interpersonal relationships, and power dynamics.

Equitable access to these diagnostic tools, driven by technological advances such as artificial intelligence, telemedicine, and digital radiography, has facilitated access to this method for different populations.

However, there are also significant challenges to its equitable distribution that affect this method, as not all regions have access to the internet or technological equipment, automated systems must be rigorously validated in different populations, and although technology reduces long-term costs, the initial investment can be high for some institutions and depends on the public health policies of different governments and technology companies.

CONCLUSIONS

The Baccetti method as a diagnostic tool is a social practice that provides orthodontists with knowledge, skills, and a tool that improves the quality of patient care, enables the organization of resources and their equitable distribution by avoiding unnecessary radiographic studies, with the aim of integrating individuals into society without aesthetic and functional impairments that are stable over time.

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CONFLICT OF INTEREST

No conflicts of interest are declared.

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