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Research Article

New Bone Biology. New Scenario: Practical Tracking of the Two Matrices (Proteica and Inorganic) in 192 Subjects in Adolescence

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Abstract

Objective: To trace the evolutionary pattern of the two bone matrices (protein and inorganic) during the period of formation of the bone support structure throughout adolescence, according to the new concepts of bone biology 13.

Method: One hundred and ninety-two subjects aged between 10 and 18 years, healthy by clinical evaluation, were submitted to bone biophysical profile screening in the distal metaphysis of the proximal phalanges of the fingers II-V, of the non-dominant hand.

Results: In the age group between 10 - 14 years, the qualitative parameter (bone protein matrix) revealed a higher value in the female group with $p < 0,01$. From the age of 15, the values in favor of the male were reversed. The quantitative parameter (inorganic matrix) in the age group between 10-14 years presented higher value in the female group with $p < 0.001$. From the age of 15, the male group overcame the female group from the age of 15.

Conclusion: The screening of the Bone Biophysical Profile revealed pulses with increasing and progressive elevation, in both sexes, both in number and in the amplitudes of ultrasound pulses. The innocuous technology when simultaneously tracking the two tools characterized the physiological and evolutionary pattern during the adolescence phase; during female puberty, the values were higher than that of male puberty. Simultaneous screening of the two matrices, in a specific site, is the current scenario of The New Bone Biology throughout adolescence.

Keywords: *Bone Physiology; Osteogenesis; Fracture Risk; Osteoporosis; Adolescence*

Abbreviations

PBO: Bone Biophysical Profile; BTT: Bone Transmission Time; AD-SoS: Speed of Sound Dependent Amplitude

Introduction

The concept of the New Bone Biology promoted a true scientific revolution in the approach of the complex bone tissue; the innovative exploration, at the molecular level, effectively provides the screening, monitoring and understanding of various dysfunctions that affect bone support structures, making it possible to detect them throughout the adolescence period [1,13].

Protein spectrophotometry characterized in different organs and systems the predominant types of proteins. In bone tissue defined as the main support structure the protein mesenchymal matrix formed mainly by collagen type I protein, which represents the primary or true bone matrix, which in turn undergoes secondary impregnation of macro, micronutrients and trace elements originating the secondary or inorganic matrix [1,2].

For more than three decades, clinical research in adolescents has reported that the predisposition to osteoporotic fractures in senile has begun at an early age, a phase that should be carried out to completely recant the bone support structure [2,3].

For decades, throughout adolescence, it was not possible to confirm the veracity of aphorism due to the limitations of ionizing tests that assess only the secondary matrix, the same occurring with the various types of X-rays (one or two wavelengths), tomography, magnetic resonance imaging, PET Scan, as well as first and second generation [13].

Nowadays it is possible to perform the complete analysis of bone tissue (structure and composition), innocuously, throughout adolescence, through the capture of electrical records of the Bone Biophysical Profile (PBO) [3-7] at a specific site of the distal metaphysis of the proximal phalanges.

In order to adapt the research projects to the clinical care and guidelines of the New Bone Biology, a pilot study was conducted that evaluated the evolutionary pattern, throughout adolescence through the Brazilian curves, first in the world, able to evaluate simultaneously and in a single place the quality and quantity extracted by the Bone Biophysical Profile (PBO) [3,5-8,22,23].

Patients and Methods

One hundred and ninety-two volunteer subjects, adolescents, students of a State Institution of Ribeirão Preto, on a weekend in March 2008 and in three task forces November 2010, December 2010 and April 2011 were submitted to the capture of the electrical record of the PBO and were distributed in two groups, namely: between 10 and 14 years (55 male and 53 female) and between 15 to 18 years (57 men and 37 women); all healthy in the clinical evaluation. The retrospective study was approved by the Ethics Committee of the University Hospital of the Faculty of Medicine of Ribeirão Preto, University of São Paulo, under number 13044/2009 whose analyses were extracted from the archive of the exams performed at Climatérium® Ltda, after informed consent and signed by responsible family members.

The PBO, its meaning (Figure 1), captured in each volunteer represents the electrical record after the passage of ultrasound through the three endotal, trabecular and cortical layers, in the region of the distal metaphysis, of the four proximal phalanges of fingers II, III, IV and V. The qualitative and quantitative tools were obtained through mathematical calculations extracted from the relationships between the amplitudes and duration of the 96 pulses extracted during the collection, according to the algorithm (Wuster., et al. 2000). The artificial intelligence carrier technology that has the exclusive ALGORITHM of the DBMBOX-4G System is patented in the European Community and USA, registered with Anvisa and certified at ICBr and INMETRO (Brazil, 2001, 2008, 2020) in the family of densitometers being called Qualitative Densitometer that predicts the risk in 10 years of developing, at ages over 60 years, Osteoporosis [5-7,10,11].

The results were analyzed according to table 1 and compared according to the new established guidelines [5,10,11,13]. In this study, only two tools were evaluated: qualitative, bone transmission time (BTT) ultrasound revolution time between apex of the first pulse and the moment of cut of the last bone protein pulse in the tail of the register, it is expressed in mseg and quantitative, speed of sound dependent amplitude (AD-SoS) obtained by automatic transmission represents the ultrasound speed(m/s) when it travels through the bone trabeculae in the four phalanges [4,5,9,11].

The technology evaluates the mechanical bone properties, in real time, without radiation emission and provides the pulses referring to the three types of bones (endotal, trabecular and cortical), the elasticity and homogeneity of bone tissue in the metaphysis of the phalanges (Figure 1). PBO is represented by a complex of increasing pulses that are integralized through an Artificial Intelligence System.

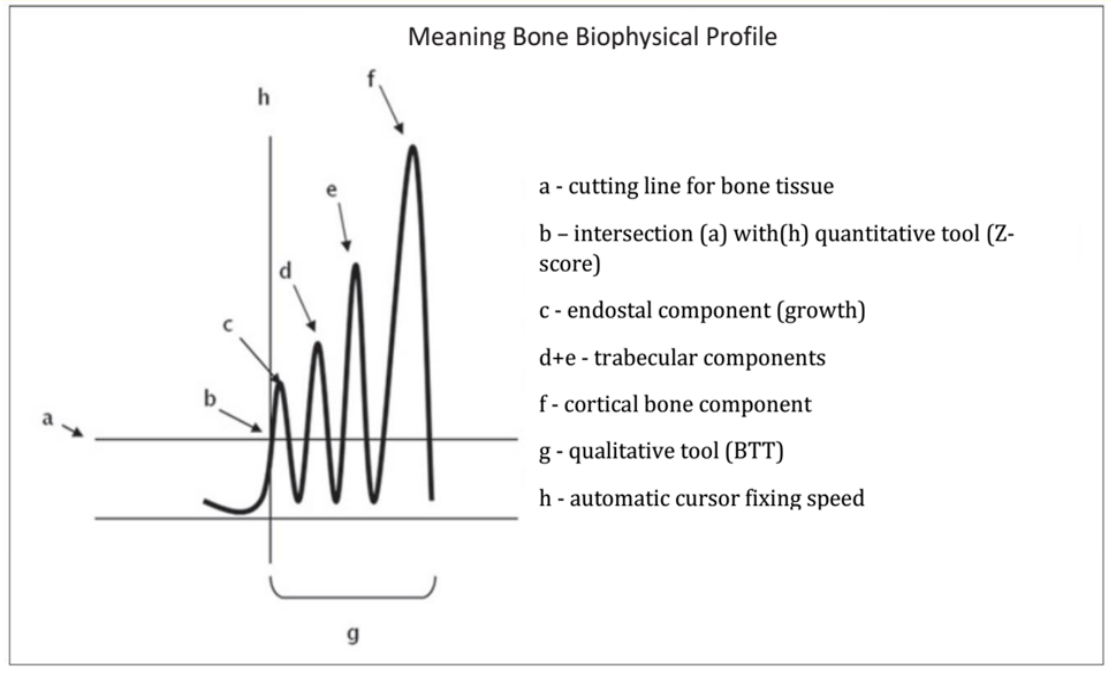

Figure 1: *Meaning of the pulses of the Bone Biophysical Profile captured in each subject. The electrical register represents the passage of ultrasound through the endostal, trabecular and cortical layers, in the region of the metaphysis distal, of the four proximal phalanges of the fingers II, III, IV and V.*

For the analysis of the measures of central tendency and multiple linear regression, the software SAS® 9.0 was used, for significance level of $p < 0.001$ and $p < 0.01$.

Results

The PBO, with advancing age, in both sexes, reveals a progressive increase in both the number and amplitude of the pulses. The quantitative parameter AD-SoS in table 1 presented an increasing and progressive value over the age groups. Between 10 - 14 years of age, females were higher than males of the same age and with significance level for $p < 0.001$. From the age of 15, the values were inversion and the male values were always higher than the female ones.

Discussion

In all medical care, clinical history and physical examination are indispensable. In the age group of adolescents it is essential to establish whether the physical-weight development is within the limits of normality.

By associating anthropometric measurements with detailed clinical examination: hair distribution, basal hormone dosages and functional tests, it is possible to evaluate the integrity of the hypothalamus-gonadal axis and related glands when faced with growth-related disorders, puberty menstrual dysfunctions and genetic disorders.

		Bone Quantity (Z-score)				Bone Quality (BTT)	
	Age	**N**	**Man ± SD**	**N**	**Woman ± SD**	**Man ± SD**	**Woman ± SD**
	10	11	1913 ± 40	13	*1925 ± 42	0,93 ± 0,16	0,91 ± 0,16
	11	10	1910 ± 33	09	*1939 ± 42	0,91 ± 0,17	*1,02 ± 0,18
	12	12	1914 ± 40	11	*1973 ± 43	0,98 ± 0,16	*1,02 ± 0,13
	13	10	1935 ± 45	10	*1990 ± 43	1,08 ± 0,21	*1,15 ± 0,17
	14	12	1962 ± 50	10	*2049 ± 43	1,24 ± 0,24	*1,35 ± 0,19
	15	11	2044 ± 62	08	2040 ± 47	1,45 ± 0,24	1,36 ± 0,18
	16	13	2069 ± 60	10	2050 ± 40	1,53 ± 0,25	1,41 ± 0,17
	17	11	2071 ± 57	10	2065 ± 48	1,65 ± 0,28	1,45 ± 0,19
	18	12	2102 ± 65	09	2089 ± 60	1,66 ± 0,24	1,59 ± 0,21
Overall		102		90			

Table 1: *Analysis of bone quantity and quality in subjects aged 10-18 years. The asterisk in the age group between 10 - 14 years refers to significant and favorable differences for women. In bold refers to the significant and favorable differences to men; after reversing the curves.*

Under these circumstances it is necessary to explore the repercussions on the bone protein matrix, and it is essential to establish the correlation between chronological ages and bone age, which, since the beginning of the last century, has been evaluated only by X-rays, ossification points and epiphyseal stages [6,11] which due to inaccuracies limit routine use, besides exposing young people to stochastic effects.

In the evaluation of bone development in adolescents, it is important to use methodologies that provide specific and regional regressive normative curves due to the glaring anthropometric differences between countries and that still include the two matrices, protein (bone quality), the inorganic matrix (bone quantity) to accurately obtain correlations with gender, ethnicity and socioeconomic condition.

In the last 50 years several methodologies have been developed and applied for this purpose, simple, peripheral, double wave X-rays, λ peripheral tomography, magnetic resonance imaging, PET Scan and ultrasound scans of calcaneus, tibia and patella. However, all evaluate exclusively the bone inorganic matrix, the secondary matrix [6,9,10,12]. The new concepts can currently be explored broadly [1]. For this reason, the US National Institute of Health, 1998 concluded that the universal value of osteoporosis screening was not established [13].

The simultaneous evaluation of the support structure and components of bone tissue is possible at the distal metaphysis site of the proximal phalanges due to providing simultaneous analysis, *in vitro and in vivo,* of the three bone types (endotal, trabecular and cortical), of the two bone components (protein and inorganic) and of the bone mechanical properties (elasticity and homogeneity).

When evaluated together the deterioration of the bone protein matrix, at any age, predicts the subjects most likely to develop different dysfunctions that may culminate in the most severe unfolding, osteoporotic fractures in senile [4,6,11,14-17].

The researches carried out in the adolescence age group emphasize the importance of avoiding radiation exposures to prevent stochastic effects, and that the methodologies applied must have adequate measurement instruments, namely: precision, high reproducibility, low coefficient of variation [5,10,15].

Similarly, when controls are carried out in the short term and the analysis of the central cause of bone tissue deterioration should be included, i.e., the bone support structure (bone quality) that together provides safety to all involved (parents, adolescents and physicians) [1,6,11,14,16,19,20].

Between 1940 and 2000, pediatric aphorism - "osteoporosis is a disease that begins in childhood" [3] cannot be confirmed due, at the time, to the methodologies available to exclusively evaluate the inorganic matrix, which is the secondary factor in the genesis of bone tissue deterioration, in the same way when osteoporosis and osteoporotic fractures [2].

The present study, in our country, mentioned in the clinic the concepts of New Bone Biology due between 10 - 18 years, the applied technology provide qualitative and quantitative bone normative curves that presented evolutionary behavior of development throughout adolescence [11,16,22].

The quantitative tool (BTT) presented an increasing and progressive value over the age groups (Table 1). The mean values between 10-14 years (Table 1) were higher in females, with significance level for $p < 0.001$, reflecting and revealing the earliest sexual maturity in females [4,7,8].

The pulses of the electrical recording of PBO (Figure 1) from the age of 10 presented increasing values up to the age of 17 years, from that date they acquire the typical pattern of those observed in young adults with normal anthropometric development.

During the sequential evaluations carried out every six months, in view of changes in bone quality and quantity, it is necessary to rule out causal factors related to growth disorders and among them stand out: hormonal-pubertal dysfunction, genetic diseases and radical changes in current habits and customs. We were told that in the simultaneous evaluation applied it was possible to detect the clear differences between the sexes from the age of 10 years and the inversion of the curves above 15 years.

The results in this study for the same age groups are similar to those in the international literature for individuals aged 3 to 21 years and Polish and German adolescents from 9 to 15 years of age [4,19]. Aspects related to "race" or "ethnic groups" certainly interfered and contributed to the differences observed between the studies [16,19]. Since Brazil is a continent country with glaring anthropometric differences, it is essential that regional regulatory curves be standardized to adapt family social inclusion to the characteristics of each region [6,7,11,22].

The qualitative and quantitative normative curves portrayed in the development phase the nuances specific to the gender and revealed magnitudes lower than those described in the international literature [4,16] and national [7,8]. When compared to the curves of patients with osteoporosis polymorphisms, osteogenesis imperfecta refer to the importance of simultaneous screening of the two matrices and in a single site, from an early age [21].

For the same reasons, in order to prevent irreversible cases of osteoporosis that affects the elderly, the technology was able to preventively trace the bone protein matrix, a central cause of fearsome osteoporosis and which can be detected to varying degrees in adolescents, women in the climacteric period and in the elderly [2,3,9,10,12,14,16,17].

The applied technology added the evaluation of the bone support structure, a scientific innovation that cannot be evidenced by the other ionizing methodologies such as: 2λ X-rays, tomography, magnetic resonance imaging and PET Scan, as well as first- and second-generation Ultrasounds for not contemplating the new paradigm of The New Bone Biology (National Institute Health, 1984), widely investigated at the molecular level, by the Genome Project (1991 - 2003) [4,5,8,10] and the vast research conducted in our country, published in PLOS ONE, 2017 [22].

For the reasons detailed throughout the work, it is a real technological and scientific innovation for contributing so much to Social Capital with Human Capital.

Conclusion

The screening of the Bone Biophysical Profile revealed pulses with increasing and progressive elevation, in both sexes, both in number and in the amplitudes of ultrasound pulses. The innocuous technology when simultaneously tracking the two tools characterized the physiological and evolutionary pattern during the adolescence phase; during female puberty, the values were higher than that of male puberty. Simultaneous screening of the two matrices, in a specific site, is the current scenario of The New Bone Biology throughout adolescence.

Conflict of Interest

None.

Funding Source

The work did not receive financial support; own investment.

Ethical Approval

The retrospective study was approved by the Ethics Committee of the University Hospital of the Faculty of Medicine of Ribeirão Preto, University of São Paulo under number 13044/2009 whose analyses were extracted from the archive of the exams performed at Climatérium® Ltda, after informed consent and signed by responsible family members.

Authors Contribution

The three authors involved in the project collaborated in the collection of the exams and in the final writing of the work. The authors agreed with the final version sent for publication and signature below. Included that this work has not been published and will not be sent to another medical journal and await the final opinion regarding its publication.

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23. 45% of Brazilians have at least one chronic non-communicable disease g1.com.br.

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