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ANALYTICAL APPROACH WITHIN CEPHALOMETRIC STUDIES ASSESSMENT IN PEOPLE WITH VARIOUS SOMATOTYPES

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ABSTRACT — Morphological studies require not only a qualitative description of the object studied, yet also a detailed account of its quantitative features. The outcome of studying lateral head teleradiographies in 127 persons with a complete set of permanent teeth and physiological occlusion was used to develop a method for measuring the jaws in the sagittal plane, as well as a method for identifying the proportion between the alveolar process anteroposterior dimensions of the upper jaw and the alveolar part of the lower jaw. Only 75.59±4.37% of the patients with physiological occlusion were found to have a proportional relationship between the sagittal dimensions of the maxillary alveolar process and the mandibular alveolar part; 14.71±4.29% of the patients had the maxillary sagittal dimensions prevailing, while 8.82±3.44% had the mandibular alveolar part prevailing over the sagittal dimensions of the maxillary alveolar process. People with the neutral type of the facial area, have a mandibular angle of 120.73±1.18°, while the maxillofacial angle shaped by the intersection of the craniofacial and mandibular planes is 43.51±2.87°. People with the horizontal facial growth type feature a significant decrease in the maxillofacial angle to 36.61±2.17°, and in case of the vertical — an increase to 51.24±1.22°. Advanced methods of dentoalveolar anomalies X-ray diagnostics would allow not only minimizing errors associated with instrumental methods employed for measuring the maxillofacial area structure, but also achieving optimal functional and aesthetic outcomes due to the orthodontic treatment predictability.

KEYWORDS — physiological occlusion; type of facial section growth; lateral teleradiography; jaw size; dental jaw segment

INTRODUCTION

The data concerning the laws of human physique development at each stage of the human body constitution knowledge is updated and refined constantly. The constitutional morphological and functional features variability limits arising from the effect of exogenous factors are determined genetically, so the content of the term constitution in modern Anthropology is interpreted as a "fairly stable comprehensive biological specifics of a person, a variant of an adaptive norm that reflects the responsive capacity and the resistance of the body to environmental factors" [13, 16, 38, 45, 49].

The key structural component of the constitution is the somatotype (morphophenotype). The somatotype acts as the most ontogenetically stable macromorphological subsystem of the general constitution, for which anthropometric measurements are available. A quantitative evaluation of a person's constitutional features performed through diagnostic features allows offering a comprehensive description of both the entire population and each individual separately. The somatotype is not only the basis for constitutional diagnosis, a morphological feature and the evaluation of health, yet is also an image of metabolic processes underway in the body. Studying homeostatic mechanisms has different levels of biosystems – from the cell to the entire body, under normal conditions and by way of adjusting to changes in the environment [18, 37, 46].

Traditional instrumental and high-tech anthropometric methods, if employed, allow identifying the qualitative and quantitative morphological features of the somatotype, their age- or gender-related, physiological or pathological variability, which, in turn, would offer a chance for an objective and reliable evaluation of the basic anatomical features [2, 5, 9, 10, 36].

When talking of identifying the somatotype, of equal clinical diagnostic value is the evaluation of the body developmental harmony, which implies proportionate ratios of its dimensional features (head, body, limbs) that make up the individual's specific features [17, 47].

Dentofacial system is one of the top human body systems in terms of the arrangement complexity, anatomical structure and the variety of functions performed. At the same time, dentofacial system, taken as the main craniofacial element, is the initial segment of the digestive and respiratory systems, also being responsible for the interconnection of the speech-related, facial and aesthetic functions [3, 7, 39, 48, 50, 56].

Understanding the growth and development patterns of the jaw bones is an important point in clinical orthodontics, which often determines the treatment tactics for occlusal anomalies, be that with or without tooth extraction [6, 20, 32, 52]. Research in this direction is relevant in applied dentistry for studying variant anatomy of teeth, jaw bones, dentofacial segments and craniofacial complex as a whole [4, 8, 11, 25, 31, 43, 51, 55].

Improved orthodontic treatment in case of dental arches shape and size anomalies, based on more efficient advanced diagnosing and treatment planning methods, which imply taking into account individual maxillofacial features, will contribute to the long-term stable outcome of complex treatment [12, 24, 30, 42].

In treating occlusion anomalies, the major issue is to identify the forecasted shape of the dental arch, which corresponds to the morphometric maxillofacial parameters, whereas the optimal balance between the morphology, function and aesthetics will facilitate significantly the process of gaining stable treatment outcomes [1, 19, 23, 26, 29, 33, 40, 53].

There have been many methods for morphometric, biometric, x-ray analysis proposed currently to carry out such studies, while each of them feature both advantages and disadvantages that have been discussed widely in respective literature [14, 22, 28, 34, 44, 54].

Most of the available generally accepted and mandatory methods are textbook entries and are inevitable in the treatment protocols for patients with occlusion anomalies, thus complementing the diagnosis and determining the treatment tactics with the orthodontist. Yet, most of the anthropometric diagnostics methods require clarification, expansion and compliance with relevant individual orthodontic requirements, taking into account the patient's individual facial orthodontic features [15, 21, 27, 35, 41].

Further elaboration of the available methods for X-ray diagnostics and treatment planning, in view of the individual maxillofacial features, will improve the effectiveness of orthodontic treatment of patients with abnormal dental arches due to the maxillary vs. mandibular size mismatch.

Aim of study

to develop a new quantitative method for identifying the maxillofacial angle and measuring the jaws in the sagittal direction subject to cephalometric data, along with the selection of the most informative indicators reflecting the structural maxillofacial features pertaining to the individual's somatotype.

MATERIALS AND METHODS

The survey involved 127 patients in their first adulthood stage (men, 22–35 years old; women, 21–35 years old) with a full set of permanent teeth and physiological occlusion. Clinical, X-ray studies were conducted in strict compliance with the ethical principles of biomedical research and obtaining voluntary informed consent of all patients. The developed and approved provisions were fully consistent with the basic ethical legal and regulatory documents required for conducting research with human participation (Nürnberg Code, 1947; World Medical Association Declaration of Helsinki, 1964).

Teleroradiograpy in the lateral projection was performed on an X-ray machine Rayscan Symphony Alpha 3D (South Korea). The results were processed using the RayScanver. 2.0.0.0 software offering the options of receiving, processing and storing data in a DICOM 3.0 compatible format. Shooting features: sensor type — CMOS; resolution detector — 630 × 1024 pixels; focal spot — 0.5 mm; voxel size – 140–230 microns; magnification — 1.3; time — 2–14 seconds; panoramic image size — 148 mm.

To analyze teleradiographies, conventional points were marked — ***N*** (*Nasion*), ***C*** (*Condylion*), ***Ar*** (*Articulare*), ***T1***, ***T2***, ***Pg*** (*Pogonion*). At the same time, the ***N*** point corresponded to the intersection of the nasolabial suture with the anterior median line (or as the frontal and nasal bones junction). The ***C*** point (or *Cond*) was located on articular head top. The ***Ar*** point was the distal articular head contour; the ***T1*** point was located on the posterior superior convexity of the lower jaw angle, whereas the ***T2*** point was located on the posterior lower convexity of the lower jaw angle. The point ***Me*** corresponded to the location of the symphysis contour lower point, and the point ***Pg*** corresponded to the anterior prominent point of the chin protrusion (Fig. 1).

In the horizontal direction, there were two lines drawn. The upper line ran through the (***N***) and (***C***) points, separating the head facial section from the cranial one, and we marked it as the head facial section plane, or the craniofacial line (***KFL***). The mandibular plane (***ML***) passed through the most convex points of the lower edge of the lower jaw body, (***Me***) and (***T2***). The intersection of these lines made up the maxillofacial angle, which could be used as an indicator for the facial growth type (horizontal, vertical and neutral). In the vertical direction, the (***N***) and (***Pg***) points were connected, which we marked as the face vertical line. The tangent line to the lower jaw branch (***Ar–T1***), together with the mandibular plane, formed the lower jaw angle. An angle measuring within 119–123° corresponded to the neutral jaw growth type. A decrease or an increase in the angle pointed at the horizontal or the vertical type of growth, respectively.

Of the variety of research methods, points and reference lines, the major references were selected for

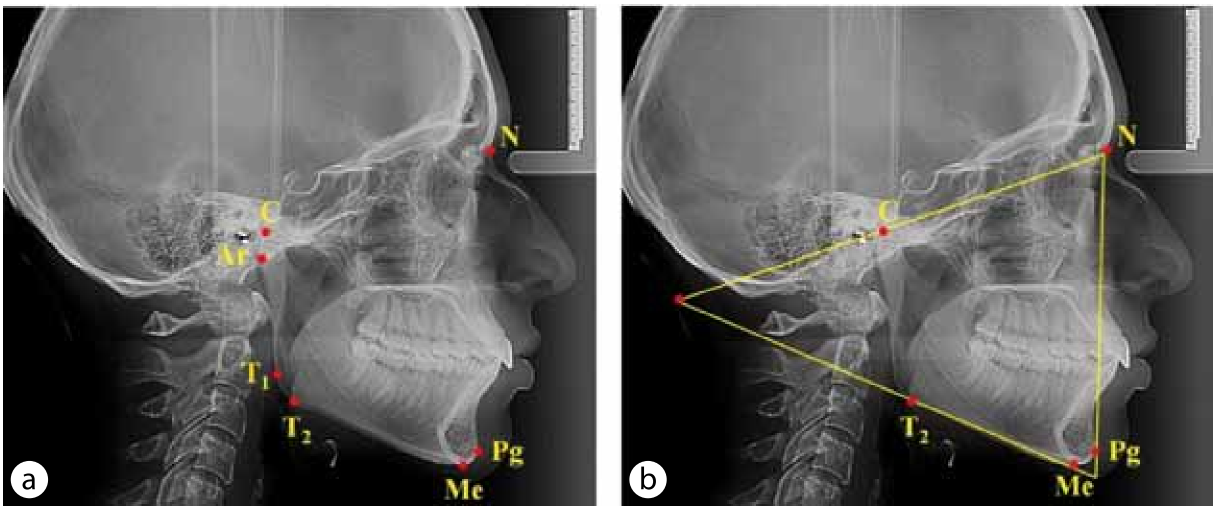

Fig. 1. Major main points (a) and lines (b) of the head lateral teleradiography.

identifying the size of the jaw apical basis: ***A*** point — the apical basis of the upper jaw or the projection of the medial superior incisor root apex on the alveolar process vestibular surface; ***B*** point — the apical basis of the lower jaw or the projection of the medial lower incisor root apex on the vestibular surface of the mandibular alveolar part. The occlusal plane was identified through conventional methods. The distal point was the vestibular distal tubercle apex of the mandibular second molar chewing surface. The anterior (interincisal) point was located in the middle between the cutting edges of the medial incisors of both jaws (Fig. 2).

For statistical analysis of the results, the software products STATISTICA 8.0 and SPSS 22.0 (StatSoft, USA) were used. For each feature, the following were determined: the arithmetic mean value and the arithmetic mean error. To identify the significance of the difference between the averages from the counterlateral sides, Student's t-criterion was identified. To examine the significance of the differences between the mean values, the dispersions analysis (ANOVA) was used.

RESULTS AND DISCUSSION

Based on the study, we proposed a method for identifying the jaw size through lateral teleradiographies.

Technique description. The occlusal plane served as the main reference point employed to identify the jaws size in the sagittal direction. The anterior reference point for the maxillary sagittal size was the structural point shaped through the intersection of the perpendicular against the occlusal plane, running from the subspinal ***A*** point. Similar design from the supramental B point was used for the lower jaw.

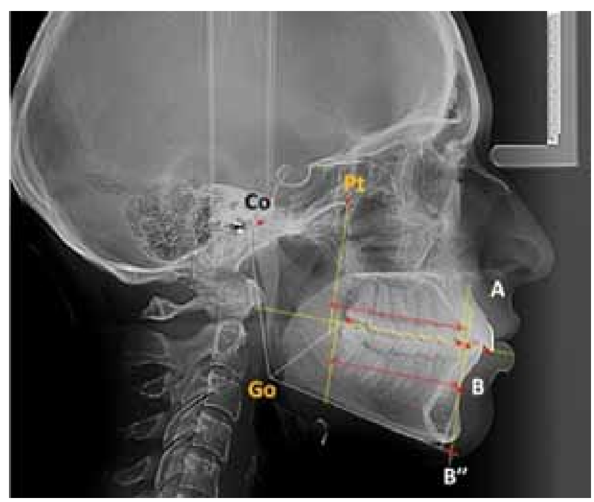

Fig. 2. Localization of points and reference lines on the lateral telegraphy for identifying the jaws size.

From the distal side, for the upper jaw, a perpendicular was drawn to the occlusal plane from the ***TM*** point located on the distal surface bulge of the tuber maxillae on the facies infratemporalis. The distance from the anterior point (***A′***) to the posterior point (***TM′***) determined the sagittal size of the maxillary alveolar process. In the lower jaw, the distal point of the alveolar part was identified at the intersection of the mandibular angle bisector with the occlusal plane. The distance from the anterior point (***B′***) to the distal point (***Go′***) was viewed as the sagittal size of the mandibular alveolar part.

The second part of the study implied identifying the proportion of the anteroposterior sizes of the maxillary alveolar process and the mandibular alveolar part on the lateral teleradiographies. The ***A′–TM′*** distance was found to correspond to the ***B′–Go′*** length in 96 people within the study group, i.e. 75.59 ± 4.37% of the total number of the patients (Fig. 3).

In 19 people (14.96 ± 3.81%), the sagittal size of the maxillary alveolar process exceeded the size of the mandibular alveolar part, an average by 2.87 ± 1.02 mm. In this case, the occlusal ratio of the antagonists corresponded to the age and physiological norm and, as a rule, was to be found in people with physiological retrusion of the upper medial incisors, which also featured an anterior displacement of the subspinal ***A*** point. In 12 patients (9.45 ± 2.76%) the mandibular alveolar part size was by 1.95 ± 1.08 mm larger than the sagittal size of the maxillary alveolar process, which in our opinion is associated with the physiological protrusion of the upper medial incisors and the upper apical basis posterior displacement (***A*** point).

The cephalometric analysis revealed that people with the neutral type of the facial area, have a mandibular angle of 120.73 ± 1.18°. At the same time, the maxillofacial angle shaped by the intersection of the craniofacial and mandibular planes was 43.51 ± 2.87°. In people with the horizontal type of facial growth, the mandibular angle was significantly smaller, 108.93 ± 3.62° ($p \leq 0.05$), in the group as a whole. A significant decrease in the maxillofacial angle to 36.61 ± 2.17° was observed, too. The vertical type of facial growth contributed to an increase in the studied angles up to 126.11 ± 2.19° and 51.24 ± 1.22°, respectively (Fig. 4).

Attention should be paid to the maxillofacial triangle features in people with various types of the head facial area growth.

People with the neutral type of growth, the height of the triangle (whose base was at the front face vertical (***N-Pg***)), divided it into approximately equal parts. The upper facial part of the maxillofacial triangle, as a rule, matched its lower facial part.

For people with the vertical type of gnathic growth, the upper facial part of the maxillofacial triangle was smaller than its lower facial part. The horizontal type of growth was accompanied by a decrease in the lower facial part of the triangle, if compared with the upper facial part.

CONCLUSIONS

1. A method has been proposed for identifying the size of the jaws in the sagittal plane, whereas the method is based on the proportion of the anteroposterior sizes of the maxillary alveolar process and the mandibular alveolar part, subject to head teleradiographies in lateral projection.

2. 75.59 ± 4.37% of the total number of the examined patients with physiological occlusion were found to have a match between the sagittal dimensions of the maxillary alveolar process and the mandibular alveolar part; 14.96 ± 3.81% of the patients had their maxillary sagittal sizes prevailing, while another 9.45 ± 2.76% of the patients had the mandibular alveolar sizes prevailing over the sagittal sizes of the maxillary alveolar process.

3. An extra criterion has been proposed to identify methods for treating malocclusion. The use of anteroposterior size ratios of the maxillary alveolar process and the mandibular alveolar part appears feasible in terms of identifying methods for treating malocclusion with or without removal of individual teeth following orthodontic indications.

4. The dimensions of the maxillofacial triangle and its components can be used as additional criteria for identifying the head facial area growth type.

5. People with the neutral type of the facial part were proven to have the size of the mandibular angle within the range of 120.73 ± 1.18°, while the maxillofacial angle was 43.51 ± 2.87°. In people with the horizontal type of facial growth, the mandibular angle parameters (108.93 ± 3.62°) and maxillofacial angle (36.61 ± 2.17°) were statistically smaller, whereas the vertical facial growth type implied an increase in the studied angles up to 126.11 ± 2.19° and 51.24 ± 1.22°, respectively.

6. Subject to the results of cephalometric, radiological studies, the localization of the standard (classical) and additional anthropometric points in the sagittal projection has been clarified. Specifying topographic data of the anatomical landmarks on the head X-ray lateral projection patterns allows increasing reliability and accessibility of the measurements; standardize anthropometric studies of the craniofacial structures in people with various somatotypes, as well as obtain a significant amount of reliable data with precise dimension features.

7. Employing X-ray diagnostics for cephalometric analysis expands significantly the current understanding of the anatomical norm variability, as determined by individual variability, gender differences, and age-related alterations, which shall serve the basis for all scientific areas of study dealing with personalized medicine.

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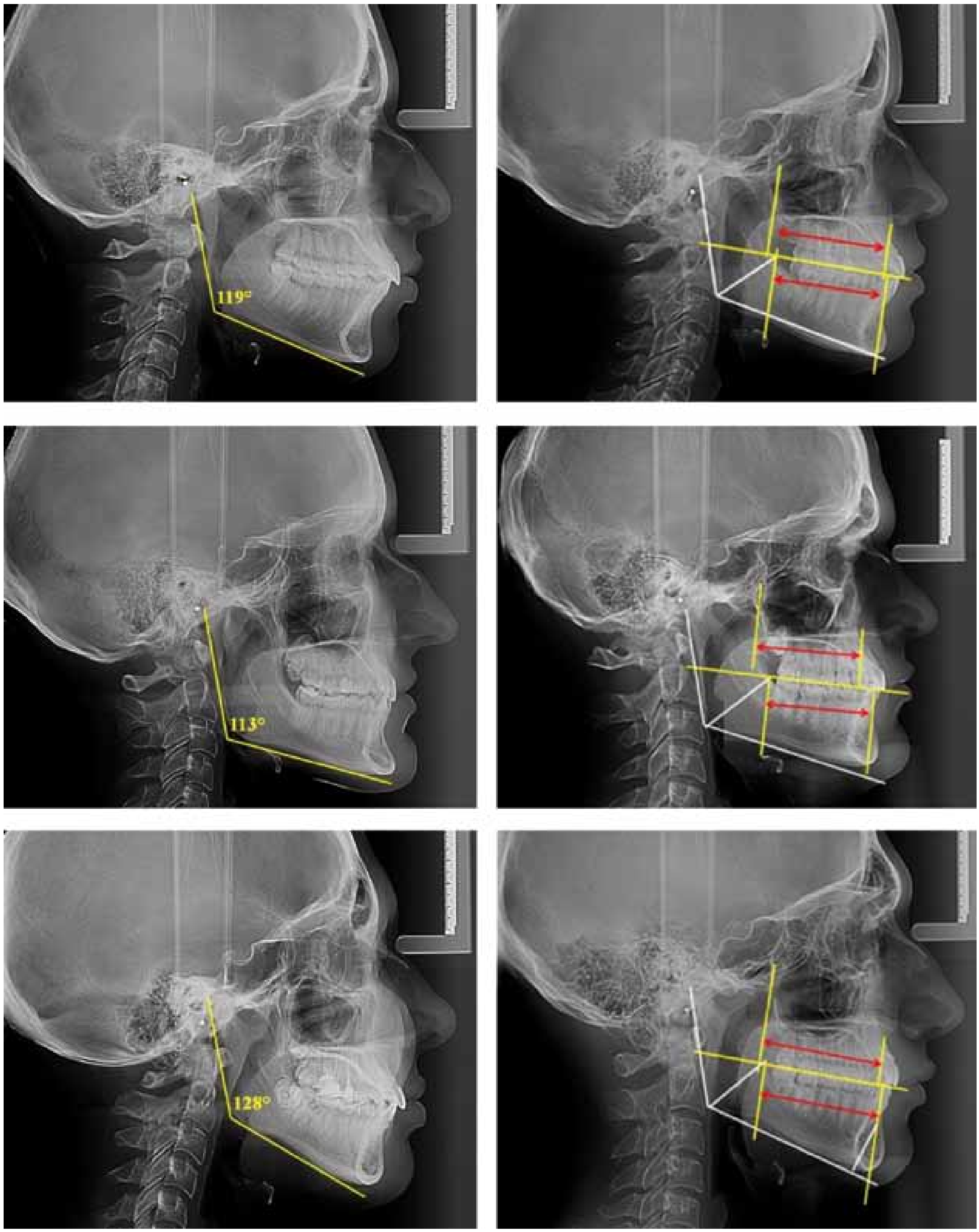

a

b

c

Fig. 3. *Specific features of the jaws size in people with a neutral (a), horizontal (b) and vertical (c) type of growth*

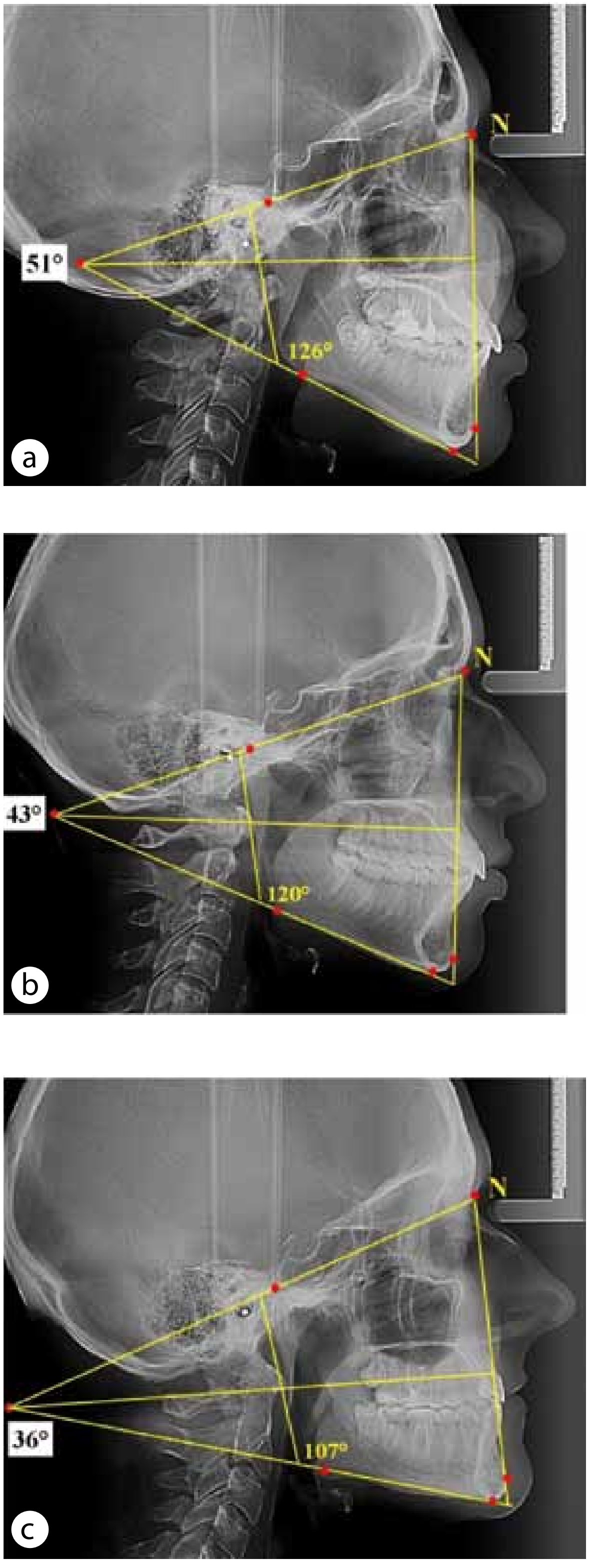

Fig. 4. Mandibular and maxillofacial angles for vertical (a), neutral (b) and horizontal (c) types of facial growth

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