Moorrees-like mesh diagram for Romanian patients - a pilot study

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DENTAL MEDICINE

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Abstract

Background and aims. In 1976, Coenraad F.A. Moorrees completed a series of facial mesh diagrams to ease the orthodontic diagnosis and treatment of North-American patients. Subsequently, the system was adapted by different authors to other races and populations. The objective of this study is to provide a system of Moorrees-like mesh diagrams for the Romanian population, Caucasian race, which would help orthodontists, surgeons and prosthetists.

Methods. 40 patients were introduced in the study, 20 males and 20 females, with ages between 12-33 years, permanent dentition and slight dental-maxillary abnormalities, class I and II Angle. For each patient, a lateral cephalometric radiograph was taken, with CRANEX 3D, head straight, maximum intercuspation. On tracing paper were drawn 35 anthropometric points and 3 planes, Frankfurt plane, as the horizontal landmark, a perpendicular line through nasion as the vertical landmark and the occlusal plane. From each point we measured the distance in millimeters to the horizontal landmark and to the vertical landmark, respectively. The obtained values were introduced into 40 tables, using Microsoft Office Excel 2007 and 3 arithmetic means were calculated, for males, for females and a general one, for children under 12 years old. The arithmetic means were transferred on millimetric paper and tracing paper, joining the obtained points and completing the templates.

Results. Three different Moorrees-like mesh diagrams were obtained, one for male, one for female and a mixt one for children under 12 years, Romanian patients, Caucasian race, respectively.

Conclusions. Mesh diagram comes in the support of a better perspective of the anatomical elements of the face and the facial growth, being a useful tool in predicting treatment. Computer based programs with Moorrees-like diagrams adapted to Romanian patients may be the object of further studies.

Keywords: Moorrees, mesh diagram, Romanian patients

Background and aims

Facial beauty is not static or constant, in fact change is the constant. This is documented by the work of many artists, starting in antiquity, continuing with the Renaissance period which culminates with the famous templates of Leonardo da Vinci. In the modern era, Albrecht Durer and his contemporaries have deepened the facial aesthetic studies [1,2]. Aesthetic requests of the patients are increasing, so an orthodontic examination is necessary not only for aesthetic reasons, but also to complete an odontological and prosthetic examination.

The value of radiography in orthodontics, as a diagnostic method, was mentioned for the first time in 1905, by Price, 5 years after the discovery of X-rays. Lateral cephalometrics was conducted in 1922 by Carrea, and radiological imaging technique for obtaining profile teleradiography was introduced in 1931 by Broadbent and Bolton. They also inaugurated the use of cephalostat in orthodontics [3]. Teleradiography provides on a single image the structure of all the elements of the dentomaxillary system: teeth, alveolar ridges, jawbones, maxillary sinuses, nasal bones, bones of the skull,

cervical vertebrae and hyoid bone. All these elements can be analyzed in order to establish an individualized diagnosis and a treatment plan accordingly [4,5].

Interpretation techniques of lateral cephalometrics are particularly numerous; any practitioner usually selects one or two techniques, although they do not have the same sensitivity for any type of abnormality. The multitude of interpretation methods can be reduced to three: metric, angular and superimposing techniques [3]. The superimposing method, the simplest for a practitioner, implies the existence of specific patterns, for the respective population, by age and sex.

Coenraad F.A. Moorrees developed on the bases of superimposing method, a system of templates, to study the most important facial aspects for orthodontic treatment. This is a method that allows appreciation of the proportion and relationships between different facial components and highlights existent changes in sagittal, vertical and transverse directions as well as facial dysmorphias and soft tissue modifications. In the 8th decade of the last century, Moorrees imagined a mesh diagram (template), corresponding to the population of North America, that allowed the assessment and the primary comparative diagnosis of patients, in order to establish a more predictable and effective treatment, the final version of the diagram being published in 1976 [6,7]. Understanding craniofacial growth and development is important for the accurate diagnosis, treatment planning and post-treatment evaluation of orthodontic cases [8]. Mesh analysis provides novel graphical as well as quantitative method of assessing craniofacial growth [9].

Because of the success in achieving the goal of Moorrees, different specialists, in different countries and regions of the world, have improved the properties of this diagram, corresponding to their population, while observing that each population has its anthropological characteristics. This means that the existence of one single diagram for the entire population would be a major source of therapeutic errors.

For this reasons, the aim of our study was to create a Moorrees-like mesh diagrams for Romanian population, which could be used in the evaluation and proper treatment of dental and maxillary abnormalities in the cephalic region. Also, mesh diagrams are a useful tool, not only to orthodontists, but also to prosthetists and orthognathic surgeons.

Methods

In the current study were included a total of 40 subjects (n=40), Romanian patients, 20 men and 20 women, ages between 12 and 33, with permanent dentition and minor abnormalities, class I and II Angle. Lateral cephalometrics were performed with CRANEX 3D radiographic device (Figure 1), heads oriented in natural head position. There were 40 radiological films obtained, transparent, bending resistant, with a standard size at a 1:1 scale.

Figure 1. CRANEX 3D radiographic device

Table I. Anthropometric points marked on tracing paper.

|	
G	Glabella
N	Nasion
Or	Orbitale
Kr	key ridge, the lowest point on the zygomatic bone
Ptm	uppermost and posterior point of the pterygo-maxillary fossa
S	Sellae
Ba	Basion
Cp	condyl posterior, radiologic and bony point posterior and lateral to mandibular condyle
Ca	condyl anterior, radiologic and bony point anterior and lateral to mandibular condyle
Mpb	mandibular posterior branch, a posterior point on the upward branch of the mandible
Mab	mandibular anterior branch, an anterior point on the upward branch of the mandible
Go	Gonion
Gn	Gnathion
Po	Pogonion
B	B Down point
Ls	lower symphysis, located lower on the chin
Us	upper symphysis, upper on the chin
Ii	incisale inferius
Is	incisale superius
Aop	anterior occlusal plane
Pop	posterior occlusal plane
A	A Down point
Ans	anterior nasal spine
Pns	posterior nasal spine
Tg	tegumentary glabella
Tn	tegumentary nasion
Sn	Subnasale
Ls	labiale superius
Li	labiale inferius
St	Stomion
Lmg	labiomentonier groove
Tp	tegumentary pogonion
Pn	Pronasale
Mia	maxillary incisor apex
Mia	mandibular incisor apex

Lateral cephalometrics were positioned on a viewing box, with the patient's face towards the right, over which tracing paper was provisionally fastened. Patient's name, surname, age and doctor's name were marked on tracing paper. Also, 35 anthropometric points used by Moorrees were marked on tracing paper (Table I).

Also, 3 planes used by Moorrees were marked on tracing paper (Table II).

Table II. Planes marked on tracing paper.

Fhp	Frankfort horizontal plane- a line that joins Orbitale inferius with Porion
VptN	Vertical plane through Nasion- a perpendicular on Frankfurt horizontal line
Op	Occlusal plane- an imaginary line passing between the upper molars cusps and the incisal edges of the inferior frontal teeth.

The distance between each anthropometric point to the horizontal and vertical plane was measured, with an electronic calliper for each patient (Figure 2). The dates were processed with Microsoft Office Excel 2007 and 40 tables were obtained.
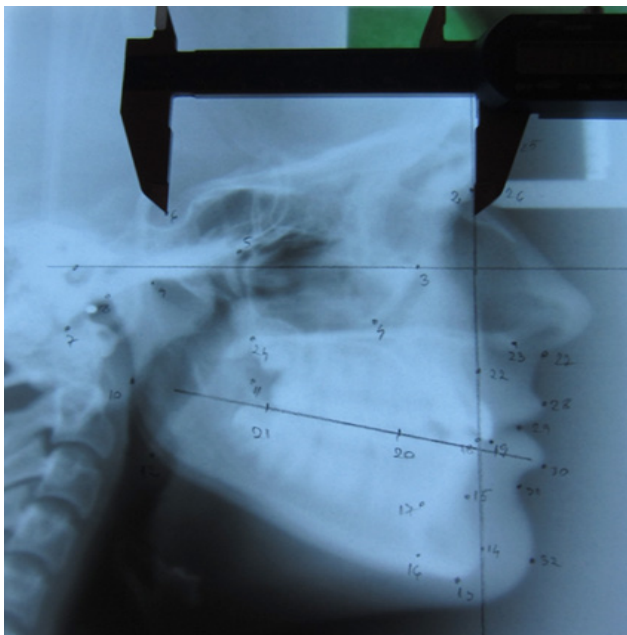
Figure 2. Measuring the distance between S and VptN

For horizontal and vertical measurements arithmetic means were calculated. Three arithmetic means resulted: one for men, one for women and a general one, that have been used to build a diagram for the treatment of children, up to 12 years (Tables III, IV, V).

The next steps in the construction of the template required transferring the distance resulted from the arithmetic means on millimetric paper, according to the tables (Figures 3,4,5). The first line transferred is the horizontal line from Frankfort. In front of it, the N-point is positioned vertically, according to the table. The vertical line through N is drawn perpendicular to the horizontal from Frankfort. Two horizontal lines are drawn, perpendicular to this vertical plane, through N and ANS. One last vertical line, parallel with the vertical line through N, goes through S. The basic diagram thus obtained is divided into four equal parts, by two coordinates. Two vertical units are added before and after the divided diagram, two horizontal units are added in the upper part and six in the lower part. Finally, twenty-four identical rectangles will form a mesh diagram. The rest of the anthropometric points are added by measuring the distance to horizontal and vertical lines, according to the tables.

Using the superimposing method, the obtained template was transferred on tracing paper. Finally, by joining the points, three Moorrees-like mesh diagrams resulted for Romanian patients, taken under study: men, women and children under 12 years old (Figures 6,7,8).

Results

The dates were processed with Microsoft Office Excel 2007.

The arithmetic mean of each point in relation to horizontal and vertical planes are presented in tables III, IV and V.

The templates on millimetric paper are listed on figures 3, 4 and 5.
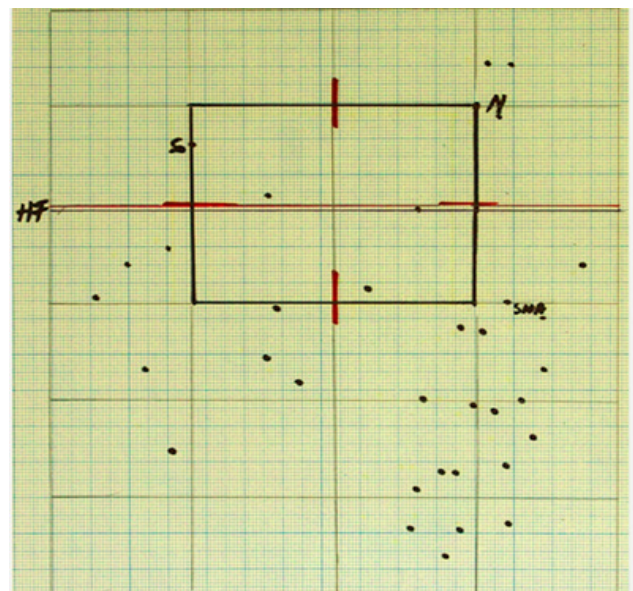
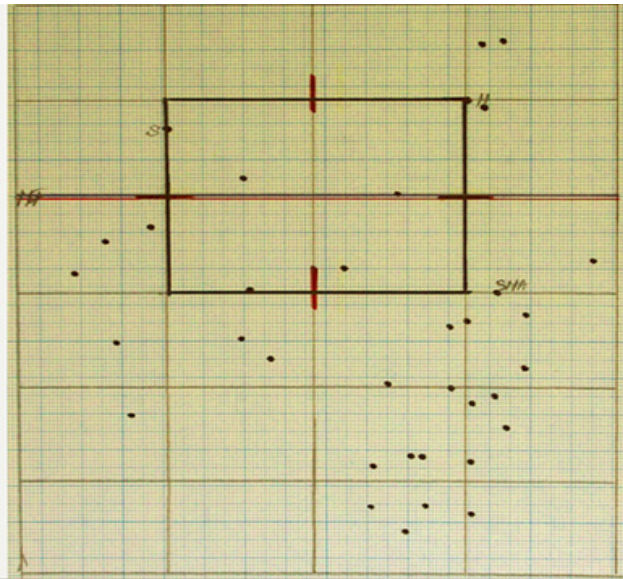**Figure 3.** Mesh diagram for men on millimetric paper.

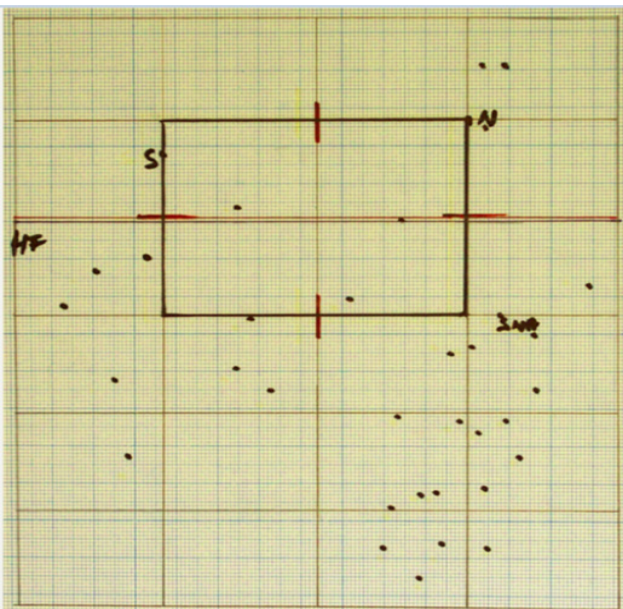**Figure 4.** Mesh diagram for women on millimetric paper.

Figure 5. Mesh diagram for children under 12 years old, on millimetric paper.

Table III. Arithmetic means for men.

Anthropometric points	Horizontal measurements	Vertical measurements
Glabela	-2.76	-41.21
Nasion	0	28.54
Orbitale	14.84	0
Key ridge	28.38	22.1
PTM	54.35	3.53
Sellae	73.84	18.88
Basion	98.28	23.35
Condyl posterior	90.56	14.41
Condyl anterior	78.37	10.07
Mandibular posterior branch	84.82	43.12
Mandibular anterior branch	53.93	40.3
Gonion	79.23	66.1
Gnathion	8.38	95.2
Pogonion	3.77	88.1
B Down point	5.33	72.35
Lower symphysis	16.92	88.53
Upper symphysis	16.49	76.85
Incisale inferius	0.13	52.59
Incisale superius	-3.76	55.23
Anterior occlusal plane	14.12	52.26
Posterior occlusal plane	46.16	46.96
A Down point	-1.16	32.75
ANS	-7.02	24.53
PNS	51.89	25.87
Tegumentary glabella	-8.68	-40.45
Tegumentary nasion	-4.86	-25.59
Subnasale	-16.03	29.45
Labiale superius	-17.4	43.92
Stomion	-10.71	51.98
Labiale inferius	-14.08	62.35
Labiomentonier groove	-6.43	70.11
Tegumentary pogonion	-8.06	86.58
Pronasale	-27.58	15.59
Maxillary incisor apex	3.91	33.72
Mandibular incisor apex	9.42	73.23

Table IV. Arithmetic means for women.

Anthropometric points	Horizontal measurements	Vertical measurements
Glabela	-3.58	-41.15
Nasion	0	25.49
Orbitale	16.38	0
Key ridge	29.39	20.32
PTM	54.62	3.91
Sellae	72.22	17.99
Basion	96.02	22.3
Condyl posterior	88.87	12.82
Condyl anterior	76.54	9.21
Mandibular posterior branch	85	41.25
Mandibular anterior branch	54.61	39.33
Gonion	81.49	60.35
Gnathion	14.68	93.28
Pogonion	9.83	85.78
B Down point	10.6	72.04
Lower symphysis	23.72	85.96
Upper symphysis	20.36	74.95
Incisale inferius	3.19	53.2
Incisale superius	-0.79	57.26
Anterior occlusal plane	19.6	51.83
Posterior occlusal plane	48.77	45.02
A Down point	0.24	34.78
ANS	-7.26	27.08
PNS	52.92	26.29
Tegumentary glabella	-9.14	-41.66
Tegumentary nasion	-3.72	-23.56
Subnasale	-14.74	32.16
Labiale superius	-14.35	47.08
Stomion	-7.15	54.55
Labiale inferius	-10.2	64.62
Labiomentonier groove	-0.98	72.79
Tegumentary pogonion	-1.15	87.91
Pronasale	-30.72	18.33
Maxillary incisor apex	4.42	36.17
Mandibular incisor apex	13.92	71.54

Table V. General arithmetic means for children under 12 years old.

Anthropometric points	Horizontal measurements	Vertical measurements
Glabela	-3.17	-41.18
Nasion	0	27.01
Orbitale	15.61	0
Key ridge	28.88	21.21
PTM	54.48	3.72
Sellae	73.03	18.43
Basion	97.15	22.82
Condyl posterior	89.71	13.61
Condyl anterior	77.45	9.64
Mandibular posterior branch	84.91	42.18
Mandibular anterior branch	54.27	39.81
Gonion	80.36	63.22
Gnathion	11.53	94.24
Pogonion	6.8	86.94
B Down point	7.96	72.19
Lower symphysis	20.32	87.24
Upper symphysis	18.42	75.9
Incisale inferius	1.66	52.89
Incisale superius	-2.27	56.24
Anterior occlusal plane	16.86	52.04
Posterior occlusal plane	47.46	45.99
A Down point	-0.46	33.76
ANS	-7.14	25.8
PNS	52.4	26.08
Tegumentary glabella	-8.91	-41.05
Tegumentary nasion	-4.29	-24.57
Subnasale	-15.38	30.8
Labiale superius	-15.87	45.5
Stomion	-8.93	53.26
Labiale inferius	-12.14	63.48
Labiomentonier groove	-3.7	71.45
Tegumentary pogonion	-4.6	87.24
Pronasale	-29.15	16.96
Maxillary incisor apex	4.16	34.94
Mandibular incisor apex	11.67	72.38

The final diagrams are presented in figures 6, 7 and 8.
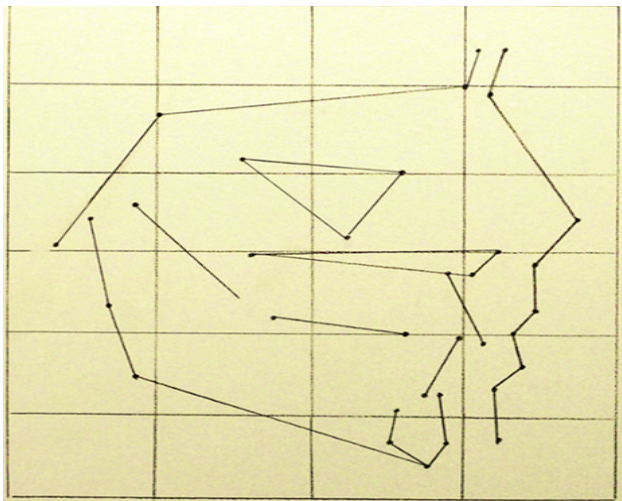

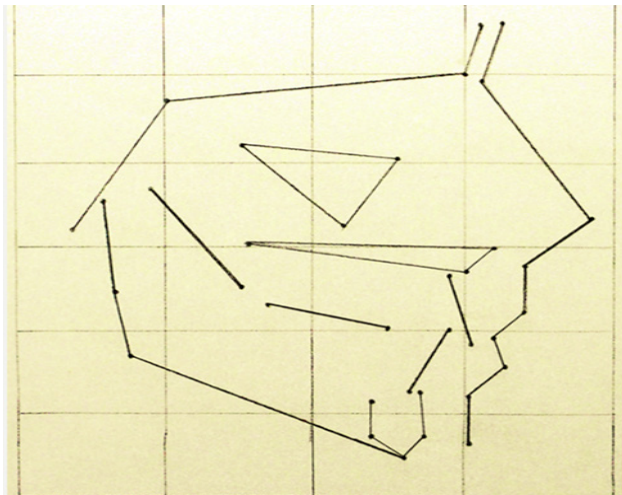**Figure 6.** Moorrees-like mesh diagram for men.

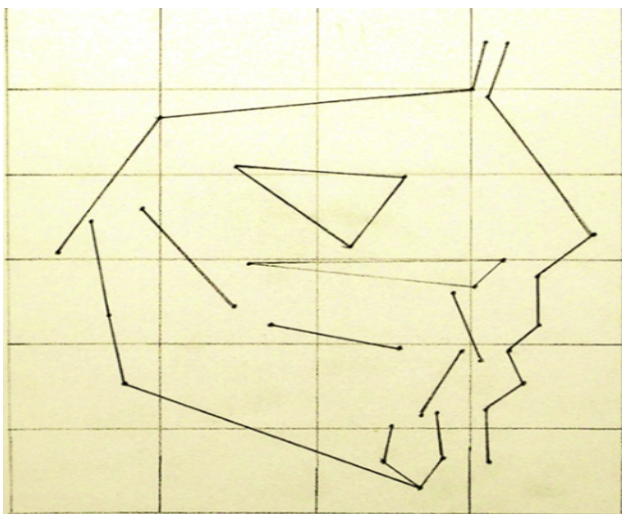**Figure 7.** Moorrees-like mesh diagram for women.

Figure 8. Moorrees- like mesh diagram for children under 12.

Discussion

The diagrams obtained were used in orthodontic patients, superimposing it on individual cephalometrics at N- point level, by rotating the diagram progressively until the horizontal and vertical reference line overlap. At this time a deviation from the standard norms, as they resulted from the diagrams, was established, facilitating the orthodontic and surgical treatment plan [10,11]. Clinical implications such as rotation of the mandible, position of the occlusal plane, position of the incisors and of the chin, have been noticed (Figures 9, 10).

Processing of lateral cephalometrics has greatly diversified, yet there is no unitary method. While approving anthropometric points, freedom of interpretation is allowed for establishing the diagnosis of abnormality. Anthropometric points used by Moorrees are the ones described by Martin and Saller in classical anthropometry [12]. The construction of the diagram was carried out in several stages: a. the horizontal line from Frankfort; b. the vertical line through N-point, that serves as origin for the coordinate system of the diagram, on which ANS is projected; c. the length of the anterior skull base (SN); d. two horizontal lines, perpendicular to the vertical plane, through N and ANS; e. one last vertical line through S-point, parallel to the vertical line through N-point. The diagram built is divided into 4 equal units by a horizontal line and a vertical one, 2 vertical units are added before and after the divided diagram, 2 horizontal units are added in the upper part and 3 times 2 horizontal units in the lower part. Finally, 24 identical rectangles will form a mesh diagram [13,14]. All these steps have been observed in the construction of the mesh diagram for Romanian patients.
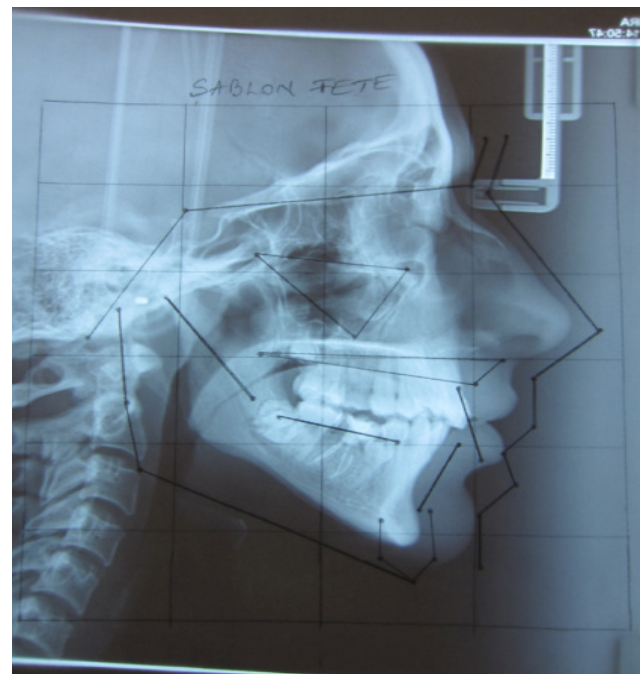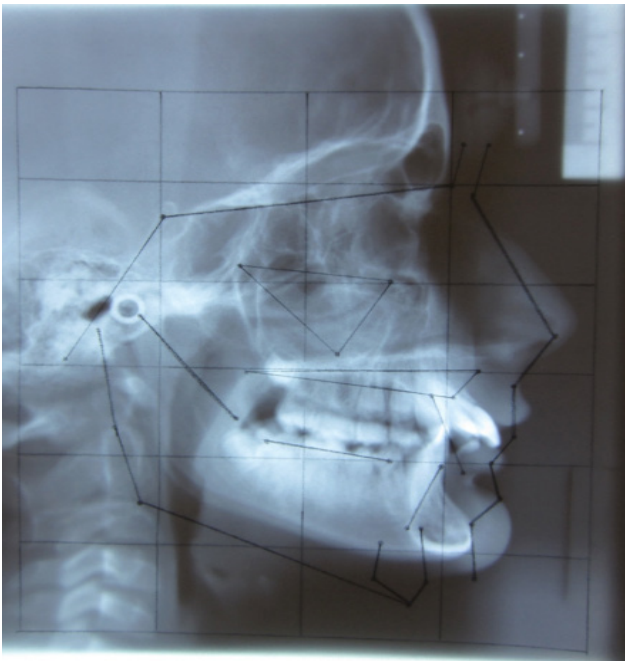

Figure 9. D.Z., female, 22 years, Angle Class I, posterior rotated mandible, high occlusion plan, retruded mandibular incisors.

Figure 10. D.A., male, 14 years, Angle class II, anterior rotated mandible, prominent chin, protruded upper incisors.

Individual variations in the position of facial and dental points are due to different facial types of the studied subjects and translate into the appearance on Moorrees diagram of some ellipses. An elongated ellipse indicates that the points are located predominantly along its long axis [15,16]. There were no variations at the N-point, nor at the ANS-point, due to the fact that ANS is used by its projection to the vertical line through N. Besides facial type, variations also occurred due to sex, with a prognathous maxilla to female gender, fact that is also highlighted in our study.

Understanding craniofacial growth and development is important for accurate diagnosis, treatment planning and post-treatment evaluation of orthodontic cases. The anterior cranial base is considered to have completed its most significant growth prior to other facial skeletal structures [17]; therefore, cranial base structures and its landmarks have been used extensively as a stable reference structure in standardized records of dento-facial structures relationship, orthodontic diagnosis and treatment planning. SN line is frequently used as a reference line to assess growth of both jaws [18]. Apparently, both sella and nasion could be displaced during growth and give rise to erroneous results when that line is used as the reference [19]. A study of nine years showed the relatively stable angle between FH and SN and a constant relationship of Po, Or, S and N points to one another [20].

For Puerto Rican Americans, a lower vertical position of the S-point in the female sex was observed, resulting in a higher rotation in the lower direction of the base of the skull [21]. The horizontal points were evaluated

along the base of the skull (SN line). Minor variations of the S-point in the vertical plane were also noticed for African Americans, due to the different inclination of the skull base for the patients under study [22]. In our study, there were no noticeable variations of the position of S-point.

Superimposing individual mesh diagrams can be done at N- point level by rotating the diagram progressively until the horizontal and vertical reference line overlap. At this time a deviation from the standard norms can be established, facilitating the orthodontic and surgical treatment plan [19,20].

For each of the interpretation techniques, computerized programs have appeared. These programs include the whole information from marking the teleradiography to the diagnosis or, after a previous copy they interprets the data by one of the methods [21,22].

Cephalometric measurements on radiographic images may be subject to errors in different working steps, such as: radiographic projection, measurement system, point mark, growth prediction [23].

For each of the interpretation techniques, computerized programs have appeared. These programs include the whole information from marking the teleradiography to the diagnosis or, after a previous copy, interprets the data by one of the methods [24,25].

Conclusions

1. Moorres-like mesh diagram is not a treatment plan; it comes to support a better perspective of the anatomical elements of the dentomaxillary system and the facial growth, in predicting treatment.

2. The current study contains a relatively small number of patients, but is a beginning in this area, that can be enriched by adding patients and recalculating on average values.

3. The errors of drawing anthropometric points can be corrected with tracing cephalometrics computerized programs.

4. Computer based programs with mesh diagrams adapted to Romanian patients may be created, excluding the radiological films and tracing paper, and giving a greater accuracy of diagnosis and treatment plan. They may be the object of further studies.

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