Guideline for manual classification of the facial profiles by CBCT image

Eliana Dantas COSTA[1]; Priscila Dias PEYNEAU[2]; Yuri NEJAIM[3];
Joseph M. CARUSO[4]; Gina Delia ROQUE-TORRES[5]

1 - Researcher, Department of Oral Diagnosis, Division of Oral Radiology, Piracicaba Dental School, State University of Campinas, Piracicaba, SP, Brazil. Professor in Department of Social Dentistry, Araraquara School of Dentistry, Univ. Estadual Paulista, UNESP, Araraquara, Brazil; **2 -** Professor, University Vila Velha, Espírito Santo, Brazil; **3 -** Professor, Federal University of Mato Grosso do Sul, Campo Grande, MS, Brazil; **4 -** Professor, Dept. of Orthodontics/Associate Dean for Strategic Initiatives and Faculty Practice, School of Dentistry, Loma Linda University, Loma Linda, CA, USA; **5 -** Research Associate, Center for Dental Research, School of Dentistry, Loma Linda University, Loma Linda, CA, USA.

Abstract

Aim: To describes step by step the procedures for manual cephalometric analysis of the facial profile was performed using the Ricketts' VERT index through software not specific for cephalometric analysis which accepts any DICOM format for cone-beam computed tomography (CBCT) images. Material and methods: The facial profile classification was performed through the arithmetic mean of the values obtained (facial axis, facial height, mandibular plane angle, lower facial height, and mandibular arch angle). Results: The present step by step can be performed by any CBCT imaging software for manual cephalometric analysis can obtain good results for Ricketts' VERT. Conclusion: Dentists, undergraduate students, educational institutions, and research that does not have access to specific software for cephalometric analysis may use the present methodology.

KEYWORDS: Students; Dentistry; Orthodontics; Cephalometry; Cone-beam computed tomography.

AUTOR PARA CORRESPONDÊNCIA
Eliana Dantas Costa
Division of Oral Radiology, Department of Oral Diagnosis
Piracicaba Dental School, University of Campinas
Av. Limeira 901, Areião, Piracicaba, SP, Zip Code 13414-903, Brazil
Phone: +55 19 2106-5327 / E-mail: edantasc@yahoo.com.br

Introduction

A bi-dimensional image is a basis for cephalometric analysis in orthodontics and orthognathic surgery. Nowadays, cone-beam computed tomography (CBCT) images can also be used for this objective[1-4], with the advantage of the absence of magnification and distortion of the anatomical structures[5].

In order to achieve this, several specific software was developed to assist orthodontists and orthognathic surgery in obtaining 3D cephalometry images[5], such as Nemotec (Nemotec, Madrid, Spain)[2,5,6] and Dolphin 3D (Dolphin Imaging, Chatsworth, Calif., USA)[5].

Materials and methods

The approval of the local research ethics committee (protocol 099/2013) was obtained. In this article, we show step by step, the procedures for manual cephalometric analysis of the facial profile using the Ricketts' VERT index[7,8] using software not specific for cephalometric analysis which accepts any DICOM format for CBCT images visualization and manipulation (e.g. CS 3D Imaging Software 3.4.3, Carestream Health Inc., Rochester, NY). The VERT index consists of 5 measures, including: facial axis, facial height, mandibular plane angle, lower facial height, and mandibular arch angle (Figure 1)[7,8]. The facial profile classification is performed through the arithmetic mean of the values obtained. Thus, the facial profile is classified as dolichofacial (Vert index below -0.5), mesofacials (Vert index between -0.49 and +0.49), and brachyfacials (Vert index above +0.5)[6,8,9].

The volume of CBCT used to demonstrate the measurements of the present study was obtained on the i-CAT (Imaging Sciences International, Hatfield, PA) unit, with acquisition protocol of 8 mA, 120 kVp, extended field of view (23 × 17 cm), 0.4 mm of voxel size and 29.6 s of acquisition time.

After loading the volume of the CBCT in the software, all volumes were reoriented (Figure 2 and Table 1):

- Sagittal Reconstruction: Check the height of the odontoid process (more central reconstruction of the skull)[1] align the anterior and posterior nasal spine. It must be parallel to the horizontal plane of Frankfurt, which is also aligned with image frame[10] and adjust the axial reconstruction line in the region of the nasal bone;

- Axial Reconstruction: adjust the sagittal reconstruction line in the center of the nasal septum.
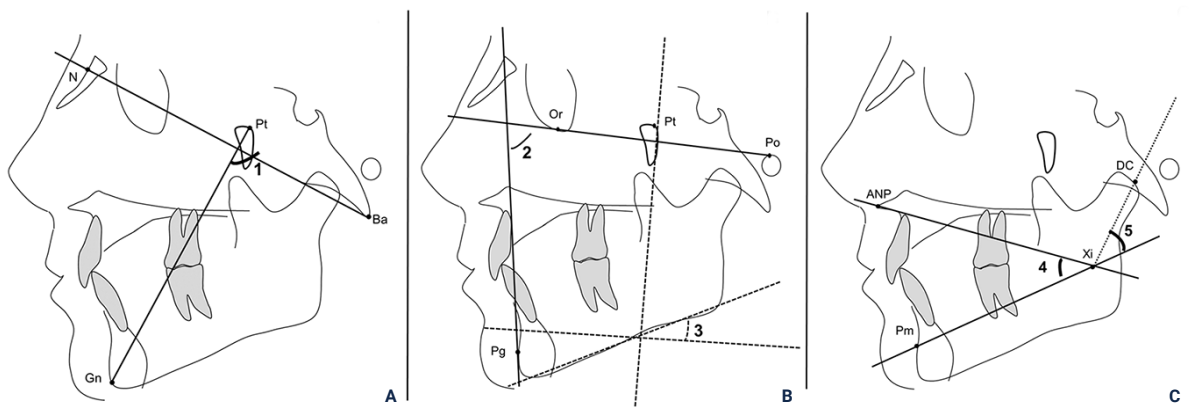

FIGURE 1 · A - (1) Facial axis. B - (2) Facial depth and (3) Mandibular plane. C - (4) Lower facial height and (5) Mandibular arch.

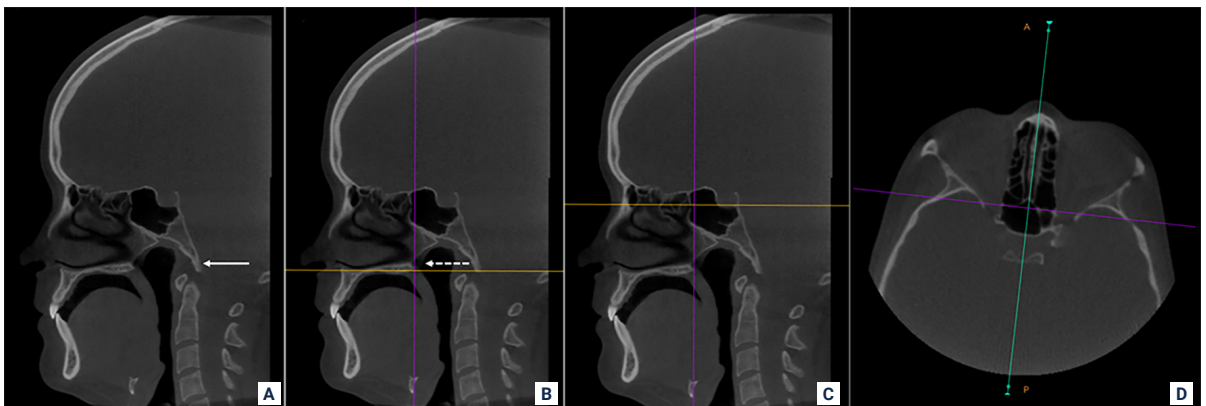FIGURE 2 · Sagittal reconstruction: (A) Greater height of the odontoid process (full arrow). (B) Alignment of the anterior and posterior nasal spine (dotted arrow). (C) Displacement of the yellow line to the nasal bone. Axial reconstruction: (D) Alignment of the orientation line in the center of the nasal septum.

TABLE 1 · Methodological procedures for the reorientation of the CBCT

Reconstruction	Procedures	Figure
Sagittal	Check the height of the odontoid process (more central reconstruction of the skull)*	2A
	Align the anterior and posterior nasal spine. It must be parallel to the horizontal plane of Frankfurt, which is also aligned with image frame **	2B
	Adjust the axial reconstruction line (horizontal reference line) in the region of the nasal bone	2C
Axial	Adjust the sagittal reconstruction line (vertical reference line) in the center of the nasal septum	2D

*According to Brasil et al.[1] (2016), da Costa et al.[2] (2017), Costa et al.[3] (2019)
** According to Katsumata et al.[10] (2005)

Results

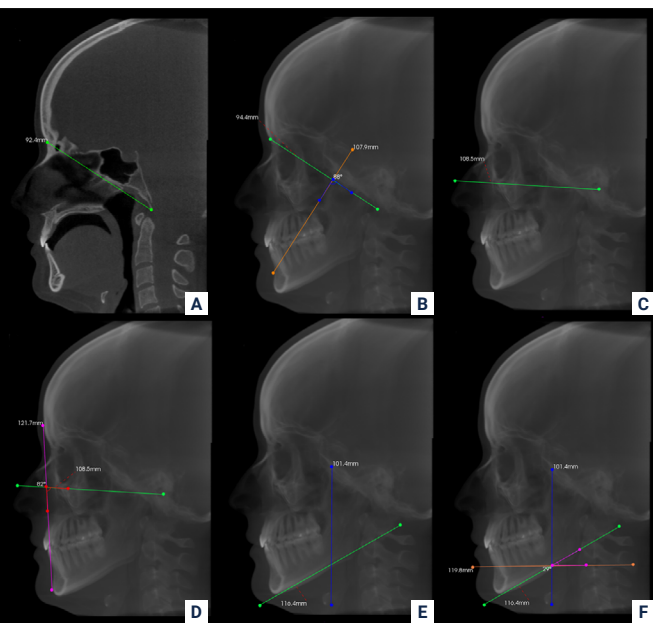The results are presented in Figures 3, 4, and Table 2.

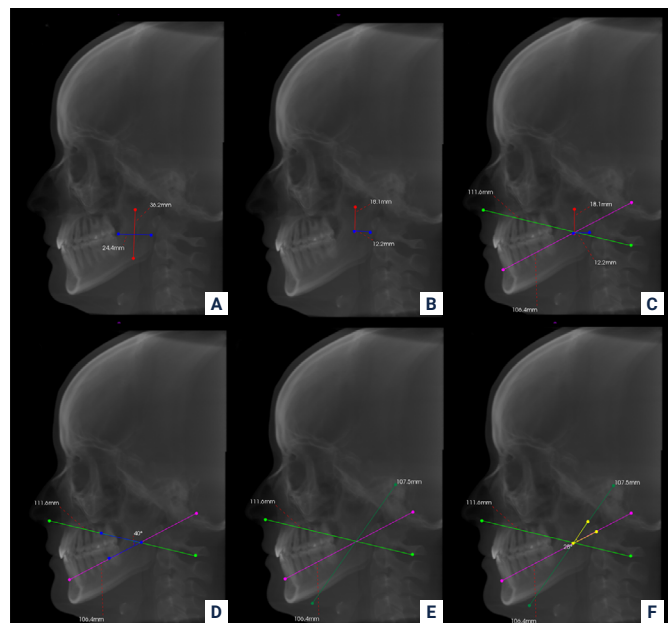**FIGURE 3** · Facial axis (A and B), Facial depth (C and D), Mandibular plane (E and F).

FIGURE 4 · Lower face height (A, B, C, D). Mandibular arch (E, F).

TABLE 2 · Procedures for the analysis of Ricketts' VERT index (Ricketts[7], 1981)

Ricketts' VERT index	Step by step	Figure
1. Facial axis	Draw a line joining the Ba (basion) and N (nasion) points	3A
	Increase the image thickness to obtain a second image with a similar characteristic to a teleradiography and adjust the contrast of the image. Draw a line in the superior-posterior region of the pterygopalatine fossa (Pt) to the most anterior and inferior points of mandibular symphysis Gn (point Gnatio) and measure the angle formed by these two lines	3B
2. Facial depth	Draw a line in the region of the Frankfurt plane (plane passing the porion (Po) to the inferior margin of the orbit (Or).	3C
	Face plane: Draw another line from the nasion (N) to the most anterior point of the mandibular symphysis – Pog (Pogonion point) Measure the internal angle formed by intersection Frankfurt plane and Face plane	3D
3. Mandibular plane	Draw a line tangent to the base of the mandible (mandibular plane) and another line tangent to the most superior-posterior region of the pterygopalatine fossa (Pt)	3E
	Draw another line parallel, which will be used as a reference line to the Frankfurt plane (Po-Or), and then displace it vertically in order to intersect with the anterior lines. Measure the internal angle in the region of the base of the mandible.	3F
4. Lower facial height	Draw a horizontal and vertical reference line to get the most central point of the mandible ramus (Xi)	4A 4B
	Trace a line from the anterior nasal spine (ANS) to the central point of the mandible ramus (Xi) Axis of the mandible's body: Trace another line from mental protuberance (Pm) to the central point of the mandible ramus (Xi).	4C
	Measure the internal angle formed by these two lines.	4D
5. Mandibular arch	Condylar Axis: Draw a line coming out of the posterior region of the condyle (DC) until Xi. Measure the angle of intersection between the condylar axis (DC-Xi) and the prolongation of the axis of the mandible's body (Pm-Xi).	4E 4F

Discussion and conclusion

Thus, Ricketts's VERT index is obtained from an average measurement of the above five factors as described[7,8]. We highlight that the present step by step can be performed by any CBCT imaging software. Dentists of any specialty, as well as undergraduate students who are in the process of learning, can use it. In addition, educational institutions and research that does not have access to software available in the market that allow the cephalometric analysis can obtain good results with this method as shown in the present study.

References

1 - American Academy of Oral and Maxillofacial Radiology. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. Position statement by the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013; 116(2): 238-57.

2 - Brasil DM, Kurita LM, Groppo FC, Haiter-Neto F. Relationship of craniofacial morphology in 3-dimensional analysis of the pharynx. Am J Orthod Dentofacial Orthop. 2016; 149(5): 683-691.

3 - Costa ED, Roque-Torres GD, Brasil DM, Bóscolo FN, Almeida SM, Ambrosano GMB. Correlation between the position of hyoid bone and subregions of the pharyngeal airway space in lateral cephalometry and cone beam computed tomography. Angle Orthod. 2017; 87(5): 688-695.

4 - Costa ED, Peyneau PD, Ambrosano GMB, Oliveira ML. Influence of cone beam CT volume orientation on alveolar bone measurements in patients with different facial profiles. Dentomaxillofac Radiol. 2019; 48(6): 20180330.

5 - Scarfe WC, Azevedo B, Toghyani S, Farman AG. Cone Beam Computed Tomographic imaging in orthodontics. Aust Dent J. 2017; 62(1): 33-50.

6 - Nejaim Y, Aps JKM, Groppo FC, Haiter Neto F. Evaluation of pharyngeal space and its correlation with mandible and hyoid bone in patients with different skeletal classes and facial types. Am J Orthod Dentofacial Orthop. 2018; 153(6): 825-833.

7 - Ricketts RM. Perspective in the clinical application of cephalometrics. The first fifty years. Angle Orthod. 1981; 51(2): 115-50.

8 - Ricketts RM, Roth RH, Chaconas SJ, Schulhof RJ, Engel GA. Orthodontic diagnosis and planning their roles in preventive and rehabilitative dentistry. 1 ed. Denver: Rocky Mountain; 1982.

9 - Bavia PF, Rodrigues Garcia RC. Vertical craniofacial morphology and its relation to temporomandibular disorders. J Oral Maxillofac Res. 2016; 7(2): e6.

10 - Katsumata A, Fujishita M, Maeda M, Ariji Y, Ariji E, Langlais RP. 3D-CT evaluation of facial asymmetry. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005; 99(2): 212-20.

Orientações para classificação manual dos perfis faciais por imagem TCFC

Resumo

Objetivo: Descrever o passo a passo dos procedimentos para análise cefalométrica manual do perfil facial utilizando o índice VERT de Ricketts por meio de software não específico para análise cefalométrica que aceita qualquer formato DICOM para imagens de tomografia computadorizada de feixe cônico (TCFC). Material e métodos: A classificação do perfil facial foi realizada por meio da média aritmética dos valores obtidos (eixo facial, altura facial, ângulo do plano mandibular, altura facial inferior e ângulo do arco mandibular). Resultados: O presente passo a passo pode ser realizado por qualquer software de imagem TCFC para análise cefalométrica manual podendo obter bons resultados para o VERT de Ricketts. Conclusão: Dentistas, alunos de graduação, instituições de ensino e pesquisadores que não possuem software específico para análise cefalométrica podem utilizar a presente metodologia.

PALAVRAS-CHAVE: Estudantes; Odontologia; Ortodontia; Cefalometria; Tomografia computadorizada de feixe cônico.