International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-5; May, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.95.4

Comparisons of Cephalometric image analysis by Information Technology (IT) in the treatment of Dentomaxillofacial Changes

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Received: 08 Apr 2022,

Received in revised form: 26 Apr 2022,

Accepted: 01 May 2022,

Available online: 09 May 2022

***Keywords*— Cephalometry, Cephalometric Analysis, Information Technology, Cefanalisys ®.**

***Abstract*—** *Cephalometry is one of the most important complementary exams in the diagnosis and planning of orthodontic, surgical, speech therapy, otorhinolaryngology and facial orthopedic treatments. The lateral cephalogram used for cephalometry can also assess the maturation of the cervical vertebrae to complement the diagnosis of bone age, orofacial dysfunction and changes in the Upper Airway (UAS). Due to the technological evolution for obtaining and interpreting images and with the emergence of software that are auxiliary in the diagnosis of orofacial alterations, the objective of this work was to develop diagnostic hypotheses and suggestions for treatments of dentomaxillofacial alterations , from comparisons of IT data. four commonly used cephalometric techniques. The software used for the analysis of the images was Cefanalis ® and the parameters Cephalometric measurements were obtained using the techniques of Jarabak , McNamara , Ricketts and USP. The advantage of having four analyzes gathered in a single software and the possibility of making cephalometric tracings of each of these techniques in combination allows the orthodontist to perform the entire procedure in his own office. More than the cephalometric tracing itself, it is possible to elaborate diagnostic hypotheses for each of the listed measures and treatment proposals for each of the changes in normality. The findings of this study made it possible to complement the data for an accurate diagnosis performed by professionals who use CCom .*

I. INTRODUCTION

The study of interventions in orofacial function and aesthetics requires clinical and technological resources for a complete evaluation. The ability of orthodontists and surgeons to recognize a symmetrical face is innate, and translating it into objective therapeutic goals becomes an arduous task.

With the advancement and popularity of orthognathic surgeries ,the search for craniofacial balance received more attention. Facial cephalometric tracings , based on lateral cephalometric radiographs, made using information technology (IT) are, today, one of the best semiotechnical options for a correct diagnosis, in addition to establishing treatment options, which provide linear dimensions. and appropriate angles of the structures of the oral and maxillofacial complex .

Therefore, the use of a clinical pattern, as well as adequate complementary exams are fundamental for the formal analysis of facial aesthetics.

In Brazil, as in other countries around the world, numerous facial cephalometric analyzes are used as complementary tests for the diagnosis of oral and maxillofacial alterations .

The different courses of Dentistry, undergraduate and graduate, usually determine one or two cephalometric analyzes as a standard to be taught to their students. However, these analyzes are not complete, that is, none is able to evaluate all the oral, maxillofacial , dental and soft tissue characteristics of a patient.

For an accurate diagnosis, the use of only a cephalometric analysis is not indicated . Therefore, the combination of several analyzes makes it possible to use a greater number of linear and angular measurements, which will allow a broader and more accurate assessment.

In order to increase the use of bioinformatics in dentistry and facilitate the practice of specialties such as orthodontics, functional maxillary orthopedics (OFM) and oral and maxillofacial surgery (CBMF), the objective of this work was to propose diagnostic hypotheses and suggestions for treatment of dentomaxillofacial alterations , from comparisons of IT data from four commonly employed cephalometric techniques, Jarabak , McNamara , Ricketts and USP.

II. MATERIALS AND METHODS

CEPHALOMETRIC MEASUREMENTS

The longitudinal assessment of craniofacial growth and development was performed using cephalometric techniques that are more widely disseminated, known and used in Brazil: Jarabak , McNamara , Ricketts and USP.

Tables 1, 2, 3, and 4 organize the measures selected and used in each of the four techniques adopted.

Table 1: Jarabak 's cephalometric analysis

MEASUREMENTS	NORMALITY
Saddle angle or skull base deflection angle	123* ± 5*
joint angle	143* ± 6*
gonial angle	130* ± 7*
superior gonial angle	52* to 55*
lower gonial angle	70* to 75*

Source: Jarabak, 1972

Table 2: Cephalometric analysis of USP

MEASUREMENTS	NORMALITY
NAP	0
SNA	82*
SNB	80*
ANB	two*
SND	76*
NS.Gn	67*
SN.PLO	14*
GoGn.PLO	18*
SN.GoGn	32*
1.1	130*
1.NA	22*
1-NA	4 mm
1.NB	25*
1-NB	4mm
1-ORBITA	5mm

1-LINE I	0
H.NB (Soft Profile)	9*-11*
H-NOSE	9 to 11mm
P-NB	4mm
FMA	25*
FMIA	68*
IMPA	87*
WITS	M- 0.0 +-1
	H- -1.5mm+1

Source: Interlandi, 1971

Table 3: McNamara 's Cephalometric Analysis

MEASUREMENTS	NORMALITY
Mandibular Plane Angle	Mixed Dentures: 25*
	Permanent Denture: 32*
Point A- (N-PERP or McNAMARA Vertical)	Mixed Denture: Point A coincident with N-PRSP
	Permanent Denture: Point A 1 mm forward N-PERP
Nasolabial Angle	110*
Upper Lip Tilt	14*± 8*
Pog (N-PERP)	Mixed Dentures: -8 to -6mm behind N-PERP
	Permanent Denture: -4 to 0mm behind
	N-PERP (up to +2mm in men)
Effective jaw length (Co-A)	Mixed Denture: 85mm
	Adult women: 94mm
	Adult men: 100mm
Effective Jaw Length (Co-Gn)	Mixed Dentures: 105 to 108mm
	Adult women: 121 to 124mm
	Adult men: 130 to 133mm
Maxillomandibular relationship	Mixed Dentures: 20 to 23mm
	Adult women: 27 to 30mm
	Adult men: 30 to 33mm
Lower Anterior Facial Height (AFAI)	Mixed Dentures: 60 to 62mm
	Adult women: 66 to 67mm
	Adult men: 70 to 74mm
(Ba-Na).(Pt-Gn)	90* ± 3.5*
(Ricketts Cephalometric Analysis)	Â - 90*= X (negative X = vertical growth)
	(Positive X = horizontal growth)
Anteroposteriorly Line A-1	4 to 6mm
Vertically 1-Ls	2 to 3mm

anteroposteriorly	1 to 3 mm ahead of the A-Pog Line
Vertically	2 to 3mm
nasopharynx	1.3 mm above the Functional Occlusal Plane
	Mixed denture: 12 mm
oropharynx	Permanent Denture: 17.4 mm
	10 to 12 mm for all ages

Source: MacNamara, 1984

Table 4 : Ricketts Cephalometric Analysis

MEASUREMENTS (Dentoskeletal)	NORMALITY
Tilt of the Occlusal Plane	22*+-4* up to the age of 8 years. Increases 0.5* per year
1.APO	22* ± 4*
1 .PO	28* ±4*
1-APO	1mm ± 2mm
1 - APO	3.5mm ± 2.5mm
Occlusal Plane to the Branch (Xi)	0mm+-3mm at 9 years and 6 months. Decreases 0.5mm per year in relation to point Xi
A6-PTV	Age +3mm ± 3mm
A6-B6 (in the Occlusal Plane)	Class I = -3mm
	Class II ≥ 0
	Class III ≤ -6mm
	Clinical Deviation ± 3mm
Canine Relationship (in the Occlusal Plane)	Class I = -2mm
	Class II ≥ +1mm or more
	Class III ≤ -5mm
	Clinical Deviation = ± 3mm
A1-B1 (Horizontal Overjet, Overjet)	2.5mm ± 2.5mm
A1-B1 (Overbite, perpendicular to the Occlusal Plane , Overbite)	2.5mm ± 2mm
B1-(B1-B6) Incisive Extrusion	1.25mm ± 2mm
interincisors	130* ± 10*
Point A convexity	2mm ± 2mm at 8 years and 6 months, decreases by 0.2 mm per year
Lower Facial Height	47*± 4*
Lip Position	-2mm ± 2mm up to the age of 8 years and 6 months, decreases by 0.2 per year
Upper Lip Length (ENA- Stm)	24mm ± 2mm at 8 years and 6 months

Union Point (Stomium -Stm) - Occlusal Plane	-3.5mm ± 2mm at 8 years and 6 months, decreases by 0.1mm per year in relation to the Occlusal Plane
Facial Depth	87* ± 3* at age 9, increases by 0.33* per year
facial axis	90* ± 3.5*
facial cone	68* ± 3.5*
Mandibular Plane Angle	26* ± 4.5* at 9 years old, decreases by 0.33* per year
Maxillary Depth	90* ± 3*
jaw height	53* ± 3* at age 9, increases by 0.4*per year
Angle formed by the Palatine Plan and the Frankfurt Plan	1* ± 3.5*
Total Face Height	60* ± 3*
Cranial Deflection	27* ± 3*
Anterior Cranial Length	55mm ± 2.5mm up to age 8.5 years, increases 0.8mm per year
Posterior Facial Height	55mm ± 3.3mm at 8.5 years, increases 0.8mm per year
Branch Position	76* ± 3*
Porium Position	-39mm ± 2.2mm at 9 years old, increases 0.5mm per year
Mandibular Arch	26* ± 4* at age 8.5 years, increases by 0.5*per year
Mandibular Body Length	65mm ± 2.7mm at age 8.5 years, increases by 1.6mm per year

Source: Ricketts, 1957

Table 5: Diagnosis and treatment parameters from Jarabak's cephalometric analysis for the Cefanalisys ® Software

MEASUREMENTS	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
Saddle Angle or Skull Base Deflection Angle - formed by the NS and S-Ar lines	123* ± 5*	> 128* Posterior skull base - absorbs more mandibular growth; leads to mandibular retrognathia (Skeletal Class II)	Protrude Mandible and/or Speech Therapy
		< 118* Posterior skull base propels mandible; leads to mandibular protrusion (Skeletal Class III)	Retracting Mandible and/or Speech Therapy Isolated interpreted compensations
Articular Angle - formed by the S-	143* ± 6*	> 149* Tooth extrusion (accentuates vertical-dolichofacial growth tendency)	Flexible wires (Nitinol) Control vertical growth and mandibular retrognathism

Ar and Ar-Go lines		< 137* Tooth Intrusion (accentuates horizontal-brachyfacial growth tendency)	Rigid Wires (Steel) Control horizontal growth and mandibular prognathism
Goniac Angle - formed by the Ar-Go and Go-Me lines	130* ± 7*	> 137* Vertical growth trend	Controlling Vertical Growth and Open Bite
		< 123* Horizontal growth trend	Control horizontal growth and Deep Bite
Gonical Angle - formed by the Ar-Go and Go-N Lines	52* to 55*	> 55* Increases sagittal growth (horizontal chin projection)	Control horizontal growth
		< 52* Greater vertical growth (vertical chin growth)	Control vertical growth
Goniac Angle - formed by the N-Go and Go-Me lines	70* to 75*	> 75* Vertical growth trend (open bite) - unfavorable prognosis (surgical)	Controlling Vertical Growth and Open Bite
		< 70* Horizontal growth tendency (deep bite) - unfavorable prognosis (surgical)	Control horizontal growth and Deep Bite

Table 6: Diagnostic and Treatment Parameters from USP Cephalometric Analysis for Cefanalisys ® Software

MEASUREMENTS	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
NAP	0	> 0 - convex profile	Advance mandible - Retract maxilla
		< 0 - concave profile	Retract mandible - Advance maxilla
SNA	82*	> 82* Protruded jaw	retract jaw
		< 82* Retracted jaw	protrude jaw
SNB	80*	> 80* Protruded jaw	retract jaw
		< 80* Retruded jaw	protrude jaw
ANB	two*	> 2* Maxilla in front of the mandible - skeletal class II	Advance mandible - Retract maxilla
		< 2* Mandible in front of Skeletal Class III Maxilla	Retract mandible - Advance maxilla

SND	76*	> 76* Mandible protruded in relation to the base of the skull	retract jaw
		< 76* Mandible retruded in relation to the base of the skull	protrude jaw
NSGn	67*	> 67* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 67* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
SNPLO	14*	> 14* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 14* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
GoGnPLO	18*	> 18* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 18* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
SNGoGn	32*	> 32* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 32* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
11	130*	> 130* Lingualized incisors	Vestibular incisors
		< 130* Factualized incisors	Lingualize incisors
1NA	22*	> 22* maxillary incisors proclined	Lingualize upper incisors
		< 22* lingual maxillary incisors	Vestibular superior incisors
1-NA	4 mm	> 4mm - Protruded upper incisors	Retract maxillary incisors
		< 4mm - Retruded maxillary incisors	Protrude upper incisors

1NB	25*	> 25* Facing lower incisors	Lingualize lower incisors
		< 25* Lingualized lower incisors	Vestibularize lower incisors
1-NB	4mm	> 4mm - Protruded lower incisors	Retract lower incisors
		< 4mm - Retruded lower incisors	Protrude lower incisors
1-ORBITA	5mm	> 5mm - Upper incisor behind the orbit, incisors proclined	Lingualize maxillary incisor
		< 5mm - Upper incisor in front of orbit, incisors lingual	Vestibular superior incisor
1-LINE I	0	Retruded lower incisor	protrude lower incisor
		< 0 - Protruded lower incisor	retract lower incisor
HNB (Soft Profile)	9*-11*	> 11* Convex profile, H-NOSE decreases	advance jaw
		< 9* Concave profile, H-NOSE increases	retract jaw
H-NOSE	9 to 11mm	> 11mm - Nose ahead of the H line (concave profile)	retract jaw
		< 9mm - Nose behind the H line (convex profile)	protrude jaw
P-NB	4mm	> 4mm - Protruded chin	retract _
		< 4mm - Petrified chin	protrude chin
FMA	25*	>25* Vertical growth trend (dolichofacial)	Decrease FMA
		<25* Horizontal growth trend (brachyfacial)	Increase FMA
		> 68* Lingualized lower incisors	Vestibularize lower incisors
		< 68* Facing lower incisors	Lingualize lower incisors

IMPA	87*	> 87* Factualized incisor	Lingualize Lower Incisors
		< 87* Lingualized incisor	Vestibular Lower Incisors

Table 7: Diagnosis and Treatment Parameters Based on McNamara 's Cephalometric Analysis for the Cefanalisys ® Software

MEASUREMENTS	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Mandibular plane angle	Mixed Dentures: 25*	> 25* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		< 25* Horizontal growth tendency (Deep bite)	Rotate jaw clockwise
	Permanent denture: 32*	>32* Vertical growth trend (Open bite)	Rotate jaw counterclockwise
		<32* Horizontal growth trend (deep bite)	Rotate jaw clockwise
RELATIONSHIP OF THE MAXILLA WITH THE BASE OF THE SKULL	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Point A	mixed denture	Point A > 0 - Protruded maxilla	retract jaw
		Point A < 0 - Retruded jaw	protrude jaw
	permanent denture	Point A > 1mm - N-PRSP Protruded maxilla	retract jaw
		Point A < 1mm - N-PRSP Retracted maxilla	protrude jaw
SOFT TISSUE EVALUATION	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
nasolabial angle	110*	> 110* Maxillary retrusion	protrude jaw
		< 110* Maxillary protrusion	retract jaw
Upper lip tilt	14* ± 8*	> 22* Protruded upper lip	Retract maxilla and anterior maxillary teeth
		Retruded upper lip	Protrude maxilla and anterior superior teeth
RELATIONSHIP OF THE JAW WITH THE BASE OF THE SKULL	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Pog -(N-PERP)	mixed denture	> 6mm - Protruded jaw	retract jaw

		< 8mm - Retruded jaw	protrude jaw
	Permanent Denture	> 0mm - Protruded jaw	retract jaw
		< 4mm - Retruded jaw	protrude jaw
RELATIONSHIP BETWEEN MAXILLA AND JAW	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Effective length of the maxilla (Co-A)	Mixed Denture: 85mm	> 85mm - Large jaw	Decrease jaw length
		< 85mm - Small jaw	increase jaw length
	Adult women: 94mm	> 94mm - Large jaw	Decrease jaw length
		< 94mm - Small jaw	increase jaw length
	Adult men: 100mm	> 100mm - Large jaw	Decrease jaw length
		< 100mm - Small jaw	increase jaw length
Effective jaw length (Co-Gn)	Mixed denture: 105 to 108mm	> 108mm - Large jaw	Decrease jaw length
		< 105mm - Small jaw	increase jaw length
	Adult women: 121 to 124mm	> 124mm - Large jaw	Decrease jaw length
		< 121mm - Small jaw	increase jaw length
	Adult men: 130 to 133mm	> 133mm - Large jaw	Decrease jaw length
		< 130mm - Small jaw	increase jaw length
maxillomandibular relationship	Mixed Dentures: 20 to 23mm	Compare the results with McNamara 's table	McNamara table
	Adult women: 27 to 30mm		
	Adult men: 30 to 33mm		
ANTERO-LOWER FACIAL HEIGHT	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Lower anterior facial height (AFAI)	Mixed Dentures: 60 to 62mm	> 62mm larger AFAI, retruded jaw	Treat open bite and/or mandibular class II
		< 60mm - Smaller AFAI, Protruded or well positioned jaw	Treat mandibular deep bite and/or Class III

	Adult women: 66 to 67mm	> 67mm - Larger AFAI, Retruded Jaw	Treat open bite and/or Class II mandibular
		< 66mm - Smaller AFAI , Jaw protruded or well positioned	Treat mandibular deep bite and/or Class III
	Adult men: 70 to 74mm	> 74mm - Larger AFAI, Retruded Jaw	Treat open bite and/or Class II mandibular
		< 70mm - Smaller AFAI, Protruded or well positioned jaw	Treat mandibular deep bite and/or Class III
FACIAL AXIS ANGLE	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
(Ba - Na)(Pt-Gn)	90* ± 3.5*	> 93.5* Horizontal growth trend	Control horizontal growth
(Ricketts Cephalometric Analysis)	Â - 90* = X	< 86.5* Vertical growth trend	Control vertical growth
RATIO OF THE UPPER INcisor TO THE MAXILLA	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Anteroposteriorly Line A- 1	4 to 6mm	> 6mm - maxillary incisors proclined	Lingualize upper incisors
		< 4mm - lingual maxillary incisors	Vestibular maxillary incisors
Vertically 1 -Ls	2 to 3mm	> 3mm - Extruded upper incisors	Intrude maxillary incisors
		< 2mm - Intruded maxillary incisors	Extrude maxillary incisors
LOWER INCISOR TO JAW RELATIONSHIP	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
anteroposteriorly	1 to 3 mm ahead of the A-Pog Line	> 3mm - Protruded lower incisor	Lower Incisor
		< 1mm - Retruded lower incisor	Protrude Lower Incisor
Vertically	1.3 mm above the functional occlusal plane	> 1.3 mm Extruded Lower Incisor	Lower Incisor
		< 1.3 mm Intruded Lower Incisor	Lower Incisor
AIRWAYS ANALYSIS	**NORMALITY**	**DIAGNOSIS**	**TREATMENT**
nasopharynx	Mixed denture: 12 mm	> 12 mm - Enlarged nasopharyngeal space	No need to treat
		< 12 mm - Decreased nasopharyngeal space	Treat lip incompetence, underdevelopment of nostrils, maxillary atresia and Posterior Crossbite (MCP), and mandibular retrognathism

	Permanent Denture: 17.4 mm	> 17.4 mm - Enlarged nasopharyngeal space	No need to treat
		< 17.4 mm - Decreased nasopharyngeal space	Treat lip incompetence, underdevelopment of nostrils, maxillary atresia and Posterior Crossbite
oropharynx	10 to 12 mm for all ages	> 12 mm - Forward positioning of the tongue	Treat lip incompetence, underdevelopment of nostrils, maxillary atresia and Posterior Crossbite (MCP), and mandibular retrognathia Speech Therapy Tonsillectomy
		< 10 mm Irrelevant	

Table 8: Diagnosis and Treatment Parameters Based on Ricketts Cephalometric Analysis for Cefanalisys ® Software

SKELETAL DENTAL	NORMALITY	DIAGNOSIS	TREATMENT SUGGESTIONS
Tilt of the occlusal plane	22*± 4* up to the age of 8 years. Increases 0.5* per year	> 26* Open bite tendency	control open bite
		< 18* Deep bite tendency	control deep bite
1.APO	22* ± 4*	> 26* Facing lower incisors	Lingualize lower incisors
		< 18* Lingualized lower incisors	Vestibularize lower incisors
1. APO	28*± 4*	> 32* maxillary incisors proclined	Lingualize upper incisors
		< 24* lingual maxillary incisors	Vestibular maxillary incisors
1-APO	1mm ± 2mm	> 3mm - Protruded lower incisors	Retract lower incisors
		< -1mm - Retruded lower incisors	Protrude lower incisors
1 - APO	3.5mm ± 2.5mm	> 6mm - Protruded upper incisors	Retract maxillary incisors
		< 1mm - Retruded maxillary incisors	Protrude upper incisors
Occlusal Plane to the Branch (Xi)	0mm ± 3mm	> 3mm - Class II	Retract maxilla - protrude mandible
		< 3mm - Class III	Protrude maxilla - retract mandible

A6-PTV	3mm ± 3mm	> age + 6mm	Distalize maxillary molar
		< age + 0mm - Distalized upper molar	Mesialize maxillary molar
DENTAL	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
A6-B6	Class I = - 3mm Class II ≥ 0 Class III ≤ - 6mm	> 0 Class II	Mesialize mandibular molar - distalize maxillary molar
		< - 6 mm Class III	Distalize maxillary molar - mesialize maxillary molar
Canine Relationship	Class I = - 2mm Class II ≥ +1mm or more Class III ≤ -5mm	> 1 mm Class II	Mesialize lower canine - distalize upper canine
		< -5mm Class III	Distalize lower canine - mesialize upper canine
A1-B1 - Overjet	2.5mm ± 2.5mm	> 5 mm - Severe overjet (Class II) Deleterious habits (bottle bottle, finger sucking)	Decrease overjet - remove harmful habits
		< 0 - Decreased Overjet (Class III) - Crossbite	Increase or maintain overjet (uncross bite)
A1-B1 - Overbite	2.5mm ± 2mm	> 4.5mm - Open bite	treat open bite
		< 0.5mm - Closed bite (greater joint damage)	treat closed bite
B1-(B1-B6) Incisive Extrusion	1.25mm ± 2mm	> 3.25mm - Lower incisor overburden	Intrude lower incisor
		< - 0.75mm - Lower Incisor Infrairruption	Extrude lower incisor
interincisors	130* ± 10*	> 140* lingual maxillary incisors	Vestibular maxillary incisors
		< 120* proclined maxillary incisors	Lingualize upper incisors
MAXILLO-MANDIBULAR RELATIONSHIP	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Point A convexity	2mm ± 2mm at 8 years and 6 months	> 4mm - Class II - maxillary skeletal	retract jaw
		< 0 - Class III - maxillary skeletal	protrude jaw

Lower Facial Height	47* ± 4*	> 51* Skeletal open bite	treat open bite
		< 43* Skeletal deep bite	treat deep bite
AESTHETICS	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Lip Position	- 2mm ± 2mm up to the age of 8 years and 6 months, decreases by 0.2 per year	> 0 - protruded lower lip	Retract lower lip if it interferes with the aesthetic plan
		< - 4mm - Retruded Lower Lip	Protrude lower lip if it interferes with the aesthetic plan
Upper Lip Length (ENA-Stm)	24mm ± 2mm at 8 years and 6 months	> 26mm - Long Lip	Speech-language pathology techniques of oral motricity to treat perioral muscles
		< 22mm - Short Lip	orthognathic surgery , Speech-language pathology techniques of oral motricity to treat perioral muscles functional jaw orthopedics
Interlabial Union Point (Stomium-Stm)	- 3.5mm ± 2mm at 8 years and 6 months	> - 1.5mm - "Hidden" teeth	Effective treatment so that the occlusal plane is below the interlabial junction point
		< - 5.5mm Short lip with gummy smile	Orthognathic surgery , speech therapy techniques of oral motricity to treat perioral musculature functional jaw orthopedics
CRANIOFACIAL RELATIONSHIP	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Facial Depth	87* ± 3* at 9 years old	> 90* Class III - concave profile	retract jaw
		< 84* Class II - convex profile	protrude jaw
facial axis	90* ± 3.5*	> 93.5* - Class III - mandibular	Control of mandibular horizontal growth, with mandibular retrusion
		< 86.5* - Class II - mandibular	Control of the vertical growth of the mandible, with mandibular protrusion
facial cone	68* ± 3.5*	> 71.5* - Class III - jaw	retract jaw
		< 64.5* - Class II - jaw	protrude jaw

Mandibular Plane Angle	26* ± 4.5* at 9 years old	> 30.5* - Class II - with convex profile	Control of vertical growth and open bite
		< 21.5 - Class III - with straight or concave profile	Control of horizontal growth and deep bite
Maxillary Depth	90* ± 3*	> 93* Maxillary protrusion - Maxillary Class II	retract jaw
		< 87* Maxillary Retrusion - Maxillary Class III	protrude jaw
jaw height	53* ± 3* at 9 years old	> 56* Increased middle third of the face	Maxilla intrusion - botulinum toxin
		< 50* Decreased middle third of the face	treat open bite
Angle formed by the Palatine Plan and the Frankfurt Plan	1* ± 3.5*	>4.5* Dental or skeletal open bite, with high probability of mouth breathing habits	Treating open bite and mouth breathing habits
		< -2.5* Dental or skeletal deep bite	treat deep bite
Total Face Height	60* ± 3*	> 63* Vertical growth trend - Class II mandibular	Protrude jaw and control vertical growth
		< 57* Horizontal growth tendency - Class III mandibular	Retract jaw and control horizontal growth
INTERNAL STRUCTURES	**NORMALITY**	**DIAGNOSIS**	**TREATMENT SUGGESTIONS**
Cranial Deflection	27* ± 3*	> 30* Excessive vertical and mandibular growth pattern - Class III	Control of vertical and mandibular growth, with mandibular retrusion
		< 24* Retrognathism tendency - Class II with micrognathia	mandibular advancement
Anterior Cranial Length	55mm +-2.5mm up to the age of 8.5 years	> 57.5mm - Class II - skeletal	Advance mandible - retract maxilla
		< 52.5mm - Class III - skeletal	Retract mandible - advance maxilla
Posterior Facial Height	55mm +-3.3mm at 8.5 years	> 58.3mm - Large mandibular ramus - horizontal growth	Control horizontal growth
		< 51.7mm - Short mandibular branch - vertical growth	Control vertical growth

Branch Position	76* ± 3*	> 79* Class III pattern - mandibular	retract jaw
		< 73* Class II pattern - mandibular	advance jaw
Porium position	- 39mm ± 2.2mm at 9 years	> - 36.8mm - Class III -skeletal tendency	Class III Control
		< - 41.2mm - Class II Tendency - Skeletal	Class II Control
Mandibular Arch	26* ± 4* at age 8.5 years	> 30* Mandibular prognathism - Class III	Retract mandible, control and treat deep bite, Advance Mandible
		< 22* Mandibular retrognathism - Class II	Control and treat open bite
Mandibular Body Length	65mm ± 2.7mm at age 8.5 years	> 67.7mm - Mandibular prognathism tendency	retract jaw
		< 62.3mm - Tendency of mandibular retrognathism	advance jaw

Index Vert : (EF)+(PF)+(PM)+(AFAI)+(AM) = X

Note : Norm minus the measurement obtained, divided by the standard deviation 5

Vertical growth trend (hourly) = negative value (dolichocephalic)

Horizontal growth trend (counterclockwise) = positive value (brachycephalic)

Dolic = -2.0; Dolic = -1.9 to -1.0; Light Dolic = -0.9 to -0.5"; Meso = -0.4 to +0.4

Brachy = +0.5 to +0.9; Braqui Severo = +1.0

USE OF THE ANALYSIS SOFTWARE

The *Cefanalisys ® software* was chosen because it has the ability to integrate and analyze the parameters of the four cephalometric techniques used in this work.

After analysis, the software issues a report with all linear and angular measurements of each of the chosen analyses, or a combination of all of them, based on the normality criteria adopted in each measurement.

From the joint analysis of the parameters studied, diagnostic hypotheses and one or more treatment suggestions for each analyzed measure were presented.

DIAGNOSTIC HYPOTHESES

The diagnostic hypotheses established for each of the measures of the cephalometric analyzes were constructed by evaluating the standard of normality adopted by the authors, establishing a diagnostic hypothesis for the quantities that are found to be smaller than the standard measure (or smaller than the minimum value of the interval considered as the standard of normality) and another diagnostic hypothesis for quantities that are found to be greater than the standard measurement (or greater than the maximum value of the interval considered as the standard of normality).

For each established diagnostic hypothesis, a treatment suggestion was constructed. These treatment suggestions were established based on the principle of existing maneuvers so that the analyzed structure assumes the normality standards indicated by the authors.

The maneuvers are limited to suggesting what should be done and not the therapeutic method that should be used to achieve the goal, that is, we point the goal to be achieved for normality, but not the method to be used to achieve this goal. .

Therapeutic methods can be orthodontic, orthopedic, surgical, all of them or different combinations of these or even others that can be adopted by the responsible professional or indicated by him.

III. RESULTS AND DISCUSSION

The parameters used in each linear and angular measurement of the cephalometric analyzes used in the *software* on screen were determined, which determined, based on the normality criteria adopted in each measurement, by their authors, at least one diagnostic hypothesis.

Based on these diagnostic hypotheses, one or more treatment suggestions were presented for each analyzed measure (**TABLES** 5, 6, 7 and 8).

Bioinformatics covers aspects of biology, acquisition, processing, storage, distribution, analysis and interpretation of data, combined with the techniques of mathematics and computing. It aims to understand the significance of biological data . Not only does it have databases and instruments to help researchers, but it can also be fully responsible for the analysis of highly complex information, which can only be evaluated by automated equipment, according to Andrade & Sander (1997); Gibas & Jambeck (2001) and Laine *et al* ., (2013).

Information systems are also applied to health. In Dentistry, the creation of *software* for the elaboration of cephalometric analyses, based on teleradiography of the patient's facial profile, has facilitated and made more efficient tools available for orthodontists, surgeons and other professionals who use this complementary exam to exercise their specialties (SCHLEYER & SPALLEK, 2001; JOHNSON, 2003).

According to Pereira; worldstock ; Berthold . (2014) Orthodontics consecrated the era of radiographic cephalometry based on the historic work of Broadbent, who developed techniques for obtaining standardized radiographs of the head. Lateral cephalometric radiography is an instrument of great value in the diagnosis, prognosis, planning and evaluation of treatment, as well as in studies of growth and development of the dentocraniofacial complex.

It is not possible to study a case in orthodontics, in its entirety, without the aid of cephalometry. Many points, lines and angles are plotted on these radiographic images according to Ricketts (1972).

The advent of cephalometry marked the end of one era and the beginning of another, allowing us to identify and measure a large number of variables that remained hidden. Since then, the diagnosis of orthodontic cases comprises two distinct aspects: clinical and cephalometric, suggested by Ramirez & Fernández (2012).

The evolution of Orthodontics, over time and due to the diversification of philosophies, techniques and orthodontic mechanics used, has contributed to reestablish, in the patient, occlusal balance and facial esthetics. Therefore, radiographic cephalometry provides many elements to professionals in their fields, whether in research or in clinical practice, providing them with information about occlusion, the relationship of bone bases of the maxilla and mandible - in a longitudinal sense - and the relationship of the positioning of the teeth.

Cephalometry is one of the most important auxiliary elements in the diagnosis and planning of orthodontic treatment, since only the Angle classification, used until the advent of cephalometry and which is clinical, is not complete.Because they understand this, several authors have proposed their analysis, such as Ricketts in 1957, Interlandi 1971, Jarabak in 1972 and McNamara in 1984.

The evolution in the diagnosis of dental occlusion alterations has gained an excellent ally: IT. With the use of dental programs, it was possible to maximize and define with some accuracy the diagnosis, treatment plan and prognosis of the patient, whatever the malocclusion. With this, it facilitated the work of the dentist, guaranteeing him greater safety (SCHLEYER; SPALLEK, 2001).

Cephalometric radiographs are used for diagnosis, treatment planning, and prognosis of soft and hard tissue responses to treatments. Normative cephalometric values have been identified as guides in diagnostic decisions, bone and tooth movements. Cephalometric analysis is used as a norm due to its ease of obtaining, measuring and comparing (superimposing) hard tissue structures and the belief that, in the case of hard tissue cephalometric norms, this results in a pleasant face.

These continuing advantages of cephalometric analysis have led to strong reliance on cephalometrics in all aspects of orthodontic, surgical and other facial interventions (SUGUINO *et al* ., 1996; BIANCHINI 2002; MORESCA *et al* ., 2002; SANTOS et al., 2002; SANTOS *et al* ., 2005; REIS *et al.* , 2006; RAMIREZ & FERNÁNDEZ 2012; PEREIRA *et al.* , 2014).

Cephalometric tracings can be performed by manual and/or computerized methods. For a long time, the manual method was the only one used to perform cephalometric tracings and obtain angular and linear measurements, but it became inconvenient due to the increasing demand and accessibility of patients to clinical and specialized dental treatment (Orthodontics/ Orthopedics/Surgery), making it impossible for the dental professional to perform so many manual tracings.

The evaluation of soft tissues is essential when looking for balance and facial aesthetics, according to Sant'ana *et al.*, 2009. The face can become more or less

aesthetically acceptable and, for this reason, cephalometric analysis is not used in isolation. It is important to analyze facial esthetics for diagnosis, planning and orthodontic and/or surgical treatment. Professionals can count on digital alternatives, in addition to radiographs, plaster models, photographs according to Schols (2003); *scanners* to capture images (VAN DER STELT, 2005); 3D printers and *scanners* intraoral according to Hurt in 2012 and the emergence of CT according to reports by Silva & Sant'Anna, 2013.

The use of CCom has grown remarkably in recent years, and it can be said that it reaches almost all cephalometric studies in clinics around the world. Ricketts (1972) led this research internationally. He himself started in 1957 defining the position of the chin in space, using basal and cranial references; oriented the maxilla (point A) in the profile , in ideal harmony for the individual and created a new A- Pogonio plane , which served as a parameter for positioning the arch. He also considered, theoretically, that the lower point A, the more lingually it would be related to the Lower Incisor and defined the values for the Lower Incisors as 1mm±1.5mm.

ricketts *et al.,* (1972) described the Summary Analysis or Analysis of the 11 factors, with angular and linear measures studied in American Caucasian subjects with normal occlusion, at the age of 9 years; this is a synthesized analysis with some of its main measurements taken from the original analysis of the 33 factors mentioned by him in 1957. The determination of facial type through cephalometry was based on the calculation of the VERT index (vertical skeletal pattern of the face) Ricketts measure , based on five cephalometric measurements (Facial Axis Angle, Facial Depth, Mandibular Plane Angle, Lower Facial Height and Mandibular Arch).

According to Pereira; worldstock ; Berthold . (2014) since the introduction of cephalometry by Broadbent in 1931, several different analyzes have been carried out. Those of Downs (1948, 1956), Steiner (1953), Tweed (1953) and Ricketts (1960, 1972) gained the most acceptance. The Wits assessment (1975, 1976) and analyzes by Jarabak(1972), Coben(1955), Wylie(1947, 1952), Sassouni(1969, 1970) are less used but well known.

McNamara (1984) stated that most of the available analyzes were conceived during the period between 1940 and 1970, when significant changes in craniofacial structural relationships were considered impossible. However, at that time, clinical Orthodontics experienced the advent of numerous orthognathic surgery procedures that allowed the repositioning of the three dimensions of almost all bone structures in the facial region and treatment by means of a Functional Orthopedic Appliance (AOF) that presented new possibilities. in the treatment of skeletal discrepancies.

For this reason, a need has arisen for new cephalometric analyzes that are sensitive not only to the position of the teeth in relation to the bone bases (maxilla and mandible), but also the relationship of the bone bases to each other.

Cephalometric tracings can be performed manually or digitally using *software* such as: *VisualBasic*® and *PorDiosW*® according to Gotfredsen, Kragskov, Wenzel (1999); *VistaDent 2.1 AT® and Jiffy Orthodontic Evaluation® (JOE) cited by Celiket al.,* (2009); *Orthometric*® cited by Sommer *et al.,* (2009) *; Dolphin Imaging 3D® and InVivo® reported by Silva and Sant'Anna* (2013 *);* among others, which provide efficiency in obtaining diagnosis, as well as help in image storage. bonilla *et al.* ;(2011) highlighted that digital cephalometry allows correcting errors generated in manual tracing and presented *Cephapoin* t ®, which allows the location of points on a computer monitor directly with the cursor, in a digital image.

cephalometric tracings are therefore used for diagnosis according to Suguino *et al* ., (1996); to assess facial growth according to Bianchini (2002) and Ramirez & Fernández (2012); to determine the facial type according to Moresca *et al* ., (2002); to plan the treatment cited by Santos *et al.,* (2005) and by Pereira *et al* ., (2014) and are important to evaluate the soft tissues cited by Sant'ana *et al* ., (2009).

In addition to being used as a complementary exam in the elaboration of the diagnosis, cephalometric analyzes are widely used in the evaluation of treatments performed and in the evolution of these treatments. Orthodontic treatments can be evaluated by cephalometric tracings according to Tien *et al* ., (2008) and Huang *et al.,* (2016); treatments with OFM as well, as stated by Araújo *et al.,* (2011) and Ko *et al* ., (2011); as well as facial surgical treatments, as assured by Filho *et al* ., (2007).

Among the cephalometric analyzes selected in this article, it can be seen that there are measures in certain analyzes that are not found in others. As an example, we cite, in the analysis of USP (1968), the Interlandi line related to the position of the Lower Incisors and the Wits index (University of Witwatersrand), defined as a linear measure and not an analysis itself. In addition to these, we also have the Tweed triangle formed by the angles FMA (*Frankfurt Mandibular Plane Angle*), IMPA (Incisor Mandibular Plane Angle) and FMIA (*Frankfurt Mandibular Incisor Angle*).

McNamara 's analysis , there are measures that allow professionals to obtain cephalometric measurements of the upper airways and the buccopharynx, which

facilitates the diagnosis and treatment of adenoids and hypertrophied tonsils.

In the analysis of Ricketts (1957) there is the VERT index of facial growth that allows the professional to determine the facial typology of the patient in: Dolichofacial (long face, tendency of vertical growth with open bite); Mesofacial (balanced and harmonious face in the facial thirds) and Brachyfacial (short face, tendency of horizontal growth with deep bite). Finally, Jarabak 's analysis (1972) provided us with important measures of the Superior, Inferior and Total Gonical Angle , which are also determinant in facial typology.

With all the measurements of the four cephalometric analyzes and with the diagnostic hypotheses and treatment options gathered in a single *software*, the clinical and/or academic daily life of the professional becomes easier and more practical. This meeting of four cephalometric analyzes is important since no cephalometric analysis alone is complete and this joint presentation brings a necessary complement to the professional for the correct diagnosis, treatment and prognosis.

The *software* and the established parameters provide the linear and angular measurements of the patient and, comparing with the standardized measurements, issues a report with diagnostic hypotheses and treatment options for each angular and/or linear measurement. This is innovative because what happens nowadays is only the offer of, at the end of the cephalometric measurements , a summary and general report for the referred analysis.

Therefore, it is evident that the professional who works with cephalometric analysis has clear and easy to interpret data, at the same time safe and faithful for the establishment of the diagnosis, treatment plan and prognosis, in a single *software* : *Cefanalysis* **®.**

IV. FINAL CONSIDERATIONS

Within the limits of this study, it can be seen that the use of Bioinformatics is increasing in Brazilian and worldwide Dentistry. It is essential to encourage research involving computational technology, expanding this science and taking knowledge to undergraduate and graduate courses, integrating students and their practices with the tools of bioinformatics.

The advantage of having four analyzes gathered in a single software and the possibility of making cephalometric tracings of each of these techniques in combination allows the orthodontist to perform the entire procedure in his own office. More than the cephalometric tracing itself, it is possible to elaborate diagnostic hypotheses for each of the listed measures and treatment proposals for each of the changes in normality. The findings of this study made it possible to complement the data for an accurate diagnosis performed by professionals who use CCom .

It is extremely important that the orthodontist and other professionals who use cephalometry as a complementary exam for diagnosis, planning, treatment and follow-up are always updated on the evolution of techniques for obtaining, interpreting and treating images, as well as all the technology made available by bioinformatics. so that all these tools are strong allies for the success of your patients' treatments.

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