A Comprehensive Manual of Basic Cephalometric Analysis

Second edition
2025

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NARAYANA
DENTAL COLLEGE AND HOSPITAL

BASIC CEPHALOMETRIC ANALYSIS

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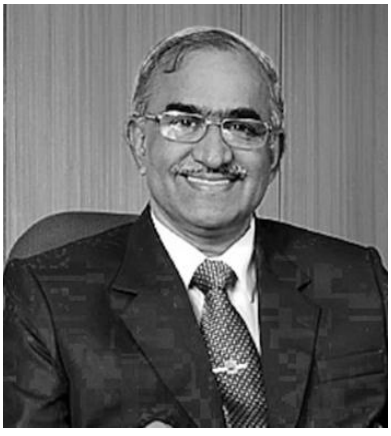
Foreword



Prof Dr. **V. Surendra Shetty** **M.D.S.**
Former Head, Department of Orthodontics,
Former Dean
Manipal College of Dental Sciences, Mangalore

Former Pro-Vice chancellor
Mangalore campus
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Karnataka, India.

It is a matter of great pride to me that my former student Dr. Gowri Sankar is one of India's most renowned Orthodontic teachers. Numerous students have cracked All-India Entrance exams with the help of his entrance books. He is an extremely committed person who loves sharing knowledge. His library dissertation during Post graduation days was on the subject of Orthodontic Cephalometric Analysis. It was an extensive work spanning 2 volumes. He has now decided to unlock this treasure for the benefit of the current generation in the form of textbook of cephalometrics.

Cephalometrics is still an essential requirement for accurate diagnosis and treatment planning in Orthodontics. It is used for many reasons - assessment of prognosis of growth modulation, planning the incisor position for long term stability, planning surgical movements, evaluation of treatment induced and growth induced changes in jaw position. In spite of 3D CBCT being very popular nowadays for many applications, 2D cephalometrics remains a reliable, time tested, low radiation alternative.

I wish Dr. Gowri Sankar all the best and wish the project great success.

PREFACE- FIRST EDITION

Going through the academic marathon in orthodontics as a student and teacher, we noticed the paucity of comprehensive textbooks devoted to all the basic cephalometric analysis published in the Orthodontic literature. We hope that this state of affairs will be remedied with the introduction of this book. This book is meant to provide an all -in-one compendium of all important cephalometric analyses for postgraduate students of Orthodontics, Oral surgery, Pedodontics, and Prosthodontics. We hope it will serve as a starter book for the course. The contents of this book are sieved material of great scholarly works in the field of cephalometrics by eminent persons. The book's contents are divided into sections for easy reading and learning. The sections are arranged sequentially and systematically. The material is very simple and uses lucid language but, at the same time, is comprehensive.

We are optimistic that this book will receive unremitting benefaction from the students and teachers. This book is also useful for practicing orthodontists as a source of reference values in cephalometrics. In this ever-expanding cornucopia of literature, we hope this book version will continue to be useful. We submit that unintentional errors may have occurred due to our ignorance of this vast subject field. We plead with the readers for any indulgence of humanerrors that may have appeared inadvertently. We always suggest that readers refer to thesource in case of ambiguity. We solicit constructive criticism for the betterment of the book.

Dr. S. Gowri Sankar Singaraju
Professor of Orthodontics
Dated 12th October 2024

PREFACE- SECOND EDITION

The overwhelming response to the first edition of "**A Comprehensive Manual of Basic Cephalometric Analysis** '' has been truly gratifying. We are happy to share that the printed version reached nearly 275 dental colleges across the country, with around 3,000 copies distributed, carrying the book even to theremotest corners. This wide circulation reaffirmed the need for a concise yet comprehensive manual devoted exclusively to cephalometric analysis.The preparation and distribution of the first edition was indeed a significant scholarly endeavor, supported by colleagues, staff, and students. Along the way, we also received numerous requests for an e-copy of the book. With the rapid growth of digitalisation and the evolving learning preferences of the Gen Z generation, it became clear that we must adapt accordingly. This Second Edition eBook, now assigned an ISBN, is a direct response to thoserequests — ensuring accessibility, portability, and free availability to every student and teacher.This book not only provides the basic knowledge of diagnosis essential for students, but also serves as avaluable resource in research activities. In this new edition, several additions have been made — including the Harmony Box, certain sagittal analyses that were previously not covered, anda Composite Analysis, which is widely included in the Indian postgraduate curriculum. We are grateful to the staff and students who pointed out errata in the first edition; these have been carefully corrected and incorporated in this version.We remain deeply thankful to the staff, colleagues, and students whose encouragement, assistance, and constructive feedback havesupported us throughout this process. Their contributions, both direct and indirect, have helpedshape this edition into its present form.It is our earnest wish that this Second Edition e-version will reach an even wider academic audience and continue to contribute to orthodontic education and practice.

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ACKNOWLEDEMENTS

No book is a one-person job; this book, particularly this edition, is no exception. I am thankful to my parents, Smt S.**Nagaraja Kumari** and Sri **S. Kameswara Rao**, who are my source of inspiration. One person I should not forget to mention in any endeavour related to my academic field is my mentor and Guide Dr. **V Surendra Shetty**. This All-In-One compendium was conceptualized during my postgraduate years when he assigned me a Library Dissertation on Cephalometric analysis. As long as this world exists, our Guru-Shishya Parampara continues. Thank you, sir, for penning down the Foreword to this book. A teacher's worth is known by the students they shape and possess. I am fortunate enough to have a group of students who motivated me and pressurized me with the intention that my LD should see the limelight and be beneficial to the students. I may be failing in my duty if I don't appreciate the everlasting and untiring efforts put in by my students and now co-authors of this book- **JS Yamini Priyanka, Thejasri Keerthipati, and Divya Ravuru** who boosted my morale to complete this book along with their involvement**.** I should especially mention the name of **Thejasri,** who is involved in each step of the book preparation- both academic and technical. The hard work of **Niharika**, **Shibitha, and Harini** as proofreaders is well acknowledged for going line to line with the contents. I am thankful to those who have contributed academically to this book.

My deep admiration goes to my senior colleague and brother, **Mandava Prasad**, for the resources he has provided in the department to modulate this book. Appreciation also goes to him for getting the sponsors for the free distribution of this book. I sincerely thank **Vivek Reddy, Johnson,** and **Ramamohan Reddy** for making this collaboration fruitful.

I am thankful to Dr. **Narayana P**, founder-chairman/ Shri**. Puneet K**- President/ **Dr. Ponguru Sindhura**- Director, Narayana Group of Institutions for supporting and encouraging scholarly and research projects. My heartfelt thanks to Dr. **Ajay Reginald. B-** Principal, Dr. **N. Siva Kumar-** Dean**,** and Dr. **KV Suneel Kumar-** Coordinator of Narayana Dental College, for sanctioning financial grants for this project and making our dreams come true. I am also thankful to all the sponsors who have supported the book's publication.

I am thankful to **Hemant** and **Kesava Rao** of Chandana Graphics for designing and timely delivery of hard copies of the book at an affordable price.

Instead of acknowledgements, the only persons I should seek apology are my better half Dr. **E Vanaja,** and my children Dr.**Kamakshi Bhavagna** and **Jagat Kaushal,** for the unintentional indifference I meted to them while preparing this book.

Above all, I prostrate before the supremacy of the all-pervading Almighty for blessing me to complete this arduous task.

– **Gowri Sankar**

At the first instance, I would like to express my sincere gratitude to **S.Gowri Sankar** sir, for giving me an invaluable opportunity to be part of this publication. Your guidance and constant support towards me are commendable. Your expertise, research skills, writing skills and tireless efforts in shaping the content and structure of this publication are truly remarkable. I thank my better half and my parents for their encouragement and support. Also, Iam indebted to **Mandava Prasad** sir and **Vivek Reddy** sir**,** who played a crucial role in my academic career as an orthodontist.

– **JS Yamini Priyanka**

ACKNOWLEDEMENTS

I express gratitude to my visionary mentor **S. Gowri Sankar** sir, for giving me the opportunity and guidance to contribute as an author for this textbook. It is a great privilege and pleasure to express my profound gratitude to him for practically guiding me in different aspects of publication and allowing me to contribute a major chunk of the book. His constant encouragement motivates me to work hard and achieve greater milestones. I am grateful for the knowledge shared by my teachers **Mandava Prasad** sir and **Vivek Reddy** sir, during my postgraduate days, which helped me contribute to this book. I thank my parents and my better half, **Sai Krishna K,** for their constant support and encouragement in this endeavour.

– **Thejasri Keerthipati**

I would like to extend my deepest gratitude to **S. Gowri Sankar** sir for believing in my abilities and providing me an opportunity to contribute as one of the authors of this textbook. His trust and support have been integral to this accomplishment. I am motivated by the humanistic approach of **Mandava Prasad** sir, HOD, and the critical analytical thinking of **Vivek Reddy** sir, my Guide during my postgraduate study. I also wish to thank my co-authors; without whose collaboration and dedication, this work would not have been possible. Lastly, I extend my heartfelt appreciation to my other senior staff, colleagues, and family, whose encouragement and assistance have been instrumental throughout this endeavour.

– **Divya Ravuru**

Dear sponsors, Thank you from the deep layers of my heart for patronizing this non-commercial project and enabling the book to reach every postgraduate of Orthodontics.

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Dr. Amir S Shaikh
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Dr.Gowri Sankar passed out BDS from GDCH, Hyderabad in 1995 and MDS from Manipal Academy of Higher Education in 1998. He authored Textbook of Orthodontics for Undergraduate Students. He has 50 publications in National and International Journals. He has 25 years of teaching experience and has served as an examiner and paper setter for various universities. He works as a Professor at Narayana Dental college, Nellore, Andhra Pradesh.

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CERTIFICATE

This is to certify that the library dissertation titled *"CEPHALOMETRICS AS AN AID IN DIAGNOSIS AND TREATMENT PLANNING"* has been done by *DR. S. GOWRI SANKAR* to my satisfaction during his period of study in the Department of Orthodontics, College of Dental Surgery, Mangalore.

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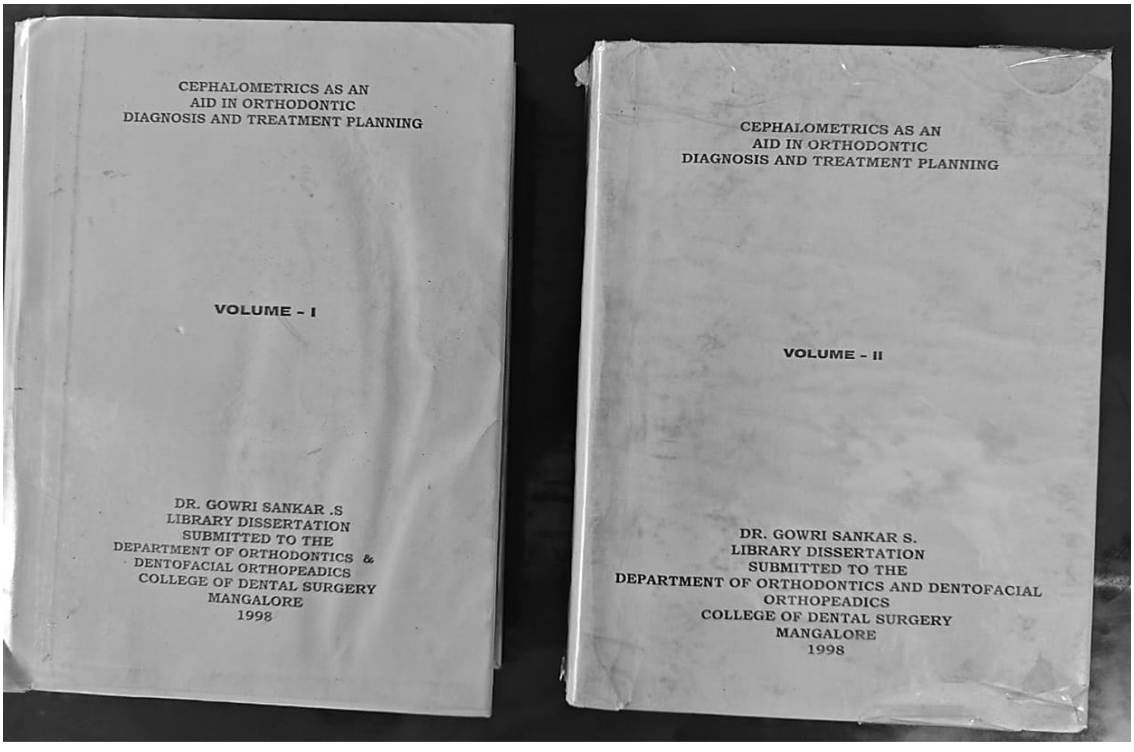

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Composite Cephalometric Analysis

Introduction

Before proceeding into the detailed chapters of this book, a Composite Cephalometric Analysis is presented here as a ready reference. This analysis brings together the most important parameters from the classical analyses of Steiner, Downs, Tweed, Ricketts, Rakosi, McNamara, and others into a single, unified format.

Advantages of the Composite Analysis

- **Integration of multiple analyses:** Combines the strengths of several established analyses, reducing the need to refer to them individually.
- **Comprehensive coverage:** Includes cranial, skeletal, dental, growth, and soft tissue parameters, ensuring no aspect of diagnosis is overlooked.
- **Angular and linear balance:** For each structure (maxilla, mandible, chin, dentition, and soft tissue), both angular and linear parameters are considered, making the assessment more reliable and clinically meaningful.
- **Uniformity in teaching and learning:** Widely followed in Indian universities for postgraduate training, ensuring consistency across institutions.
- **Quick reference for exams and clinics**: Saves time by presenting all essential values in one place, useful during practical examinations and daily case discussions.
- **Diagnostic clarity:** Provides normal values and inferences that help students and clinicians immediately identify deviations and classify skeletal, dental, or soft tissue discrepancies.

The normal values provided in this template are the same as those found in the respective individual analyses described later in this book. By first understanding this composite framework, students can better appreciate the contribution of each author's analysis when studied in detail.

Note to Students: Practice this composite analysis tracing as a routine exercise, since it forms the foundation of orthodontic diagnosis and is a compulsory component of postgraduate examinations.

Table.1. Composite Cephalometric Analysis with Norms + Inferences

S.No	Parameter		Norm	Inference	Source
I.	**Cranial Parameters**				
1.	Saddle angle (N–S–Ar)	Angular	123° ± 5°	A decreased angle indicates Class III skeletal tendency; an increased angle indicates Class II tendency.	Bjork/Jarabak/ Rakosi
2.	Articular angle (S–Ar–Go)	Angular	143° ± 6°	A larger angle suggests downward and backward mandibular growth rotation; a smaller angle suggests forward mandibular growth.	Bjork/Jarabak/ Rakosi
3.	Gonial angle (Ar–Go–Gn)	Angular	128°–130°	A larger gonial angle suggests vertical growth pattern; a smaller angle suggests horizontal growth pattern.	Bjork/Jarabak/ Rakosi
4.	Upper Gonial angle (Ar–Go–N)	Angular	50°–55°	A smaller angle indicates a short ascending ramus.	Bjork/Jarabak/ Rakosi
5.	Lower Gonial angle (N–Go–Gn)	Angular	72°–75°	A larger angle suggests vertical growth; a smaller angle suggests horizontal growth.	Bjork/Jarabak/ Rakosi
6.	Sum of angles	Angular	39□° ± 6°	An increased sum indicates vertical growth tendency.	Bjork/Jarabak/ Rakosi
7.	Cranial base angle (SN–Ba)	Angular	130°–135°	An obtuse angle indicates Class II skeletal relation; an acute angle indicates Class III tendency.	Bjork
8.	Cranial deflection (Ba–N–Pt / FH	Angular	27° ± 3°	Increased → Class II tendency; decreased → Class III tendency.	Ricketts
II.	**Skeletal – Maxilla**				
9.	SNA	Angular	82° ± 2°	A higher value indicates a prognathic maxilla; a lower value indicates a retrognathic maxilla.	Reidel (Steiner)
10.	N ⊥ to Point A	Linear	0 ± 2 mm	Positive values indicate forward positioning of the maxilla; negative values indicate retrusion.	McNamara/ Down
11.	NA Linear	Linear	Males- 0±3.7mm Females- -2±3.7mm	A larger angle suggests a forwardly placed A-point; a smaller angle indicates a backward A-point.	COGS- Burstone
12.	Effective maxillary length (Co–A) (Mcnamara)	Linear	87 mm	Increased length indicates long midface; decreased length indicates maxillary deficiency. Must be coordinated with mandibular length.(Mcnamara)	Mcnamara
13.	Absolute Palatal/ maxillary length)PNS–ANS	Linear	Males 57.7 ± 2.5mm Females 52.6 ± 3.5 mm	Increased length indicates long Palatal/ maxillary length; decreased length indicates short Palatal/ maxillary length	COGS/ later used by Rakosi

III. Skeletal – Mandible					
14.	SNB	Angular	80° ± 2°	A higher value indicates prognathic mandible; a lower value indicates retrognathic mandible.	Reidel (Steiner)
15.	N ⊥ to Pog	Linear	0 to –4 mm	Positive values indicate prominent chin; negative values indicate deficient chin.	Downs
16.	NB	Linear	Males- -5.3± 6.7mm Females- –6.9 ± 4.3mm	Positive values indicate protrusive chin(mandible); negative values indicate retrusive chin.	COGS-Burstone
17.	N–Pog	Linear	Males - -4.3±8.5 Females –6.5 ± 5.1 mm	Deviations suggest abnormal mandibular base positioning as above.compare with NB above.	COGS-Burstone
18.	Effective mandibular length (Co–Gn) (Mcnamara)	Linear	109–112 mm	Larger length indicates large mandible; smaller length indicates mandibular deficiency. Must be coordinated with maxillary length.(Mcnamara)	Mcnamara
19.	Go–Pog (Corpus length)	Linear	74.3 ± 5.8 mm	A shorter length indicates a short mandibular body.	Schwarz (original), later used by Rakosi
IV. Skeletal – Chin					
20.	SND	Angular	76°	A smaller angle suggests retrognathic mandible/chin.	Stiener
21.	B–Pog	linear	males 8.9±1.7 Females 7.2 ± 1.9mm	A smaller values suggests reduced chin; a larger angle suggests increased chin thickness.	Rakosi, Burstone(COGS)
22.	Facial depth (FH–N–Pog)	Angular	87° ± 3°	A larger value suggests forward chin; a smaller value indicates retruded chin.	Downs
IV. Skeletal Pattern- Sagittal Maxillo mandibular dysplasia					
23.	ANB	Angular	2° ± 2°	>4° indicates skeletal Class II; <0° indicates skeletal Class III.	Reidel (Steiner)
24.	Convexity at Point A	Linear	2 ± 2 mm	A larger value indicates convex profile; a smaller value indicates straight/concave profile.	Downs/ Ricketts
25.	Wits appraisal	Linear	AO > BO	AO far ahead of BO indicates Class II; BO ahead of AO indicates Class III.	Jacobson
26.	Beta angle	Angular	27°–35°	<27° indicates Class II; >35° indicates Class III.	Baik & Ververidou

VI.. Growth Pattern- vertical dysplasia					
27.	FMA (Tweed)	Angular	25°	>30° indicates vertical growth tendency; <20° indicates horizontal growth.	Tweed/ Downs
28.	Y-axis (Downs)	Angular	66°	A larger angle indicates vertical growth; a smaller angle indicates horizontal growth.	Downs
29.	LAFH (ANS–Me)	Linear	61–63 mm	A larger value indicates long lower face; a smaller value indicates short lower face.	MCnamara/Rakosi
30.	Jarabak ratio (PFH/AFH)	Ratio	62–65%	>65% indicates horizontal growth; <62% indicates vertical growth.	Jarabak/Rakosi
VII. Jaw Rotations					
31.	Angle of inclination (palatal plane inclination)	Angular	85°	A larger angle indicates anticlockwise rotation of the maxilla (palatal plane); a smaller angle indicates clockwise rotation.	Jarabak/ Rakosi
32.	Basal plane angle (Maxillary–Mandibular base)	Angular	25°	A larger angle suggests divergent jaw bases; a smaller angle suggests convergent bases.	Bjork
33.	Palatal plane – occlusal plane (PP–OP)	Angular	11°	A larger angle indicates a steep occlusal plane; a smaller angle indicates a flat occlusal plane.	Rakosi
34.	Occlusal plane to Mandibular plane (OP–MP)	Angular	14°	A larger angle suggests divergent occlusal–mandibular planes.	Rakosi
VIII. Dental – Upper Incisors					
35.	U1–NA	Angular/linear	22°4, mm	Larger values indicate proclination/protrusion; smaller values indicate retroclination/retrusion.	Steiner
36.	U1–A	Linear	4 mm	Positive values indicate protrusive upper incisors.	McNamara
37.	U1–SN	Angular	102° ± 2°	A larger value indicates proclination; a smaller value indicates retroclination.	Rakosi
38.	U1–PP	Angular	70° ± 5°	A smaller value indicates proclination; a larger value indicates retroclination. (*reverse as inferior angle is measured).	Rakosi
IX. Dental – Lower Incisors					
39.	L1–NB	Angular/linear	25°,4 mm	Larger values indicate proclination/protrusion; smaller values indicate retroclination/retrusion.	Steiners

40.	L1–A–Pog	Angular/linear	1 ± 2 mm, 22° ± 4°	A larger value indicates proclined incisors; a smaller value indicates retroclined incisors.	Ricketts
41.	L1–MP	Angular	90° ± 3°	A larger value indicates proclination; a smaller value indicates retroclination.	Tweed/ Rakosi
42.	IMPA	Angular	90°	Larger values indicate proclination; smaller values indicate retroclination.	Tweed
43.	FMIA	Angular	65°	A smaller value indicates proclined incisors. The value should be maintained at 65-70.	Tweed
X. Soft Tissue					
44.	Facial angle (FH–N'–Pog')	Angular	90°	A smaller angle indicates retrognathic chin; a larger angle indicates prominent chin.	Holdaway/ Burstone
45.	Nasolabial angle	Angular	90°–110°	An acute angle (<90°) suggests proclined maxillary incisors/protrusive upper lip; an obtuse angle (>110°) suggests retruded incisors or deficient lip support.	Holdaway/ Burstone
46.	H-line angle (Holdaway)	Angular	7°–15°	A larger angle indicates protrusive lips; a smaller angle indicates retrusive lips.	Holdaway
47.	Upper sulcus depth	Linear	5 mm	A smaller value indicates deficient upper lip support.	Holdaway
48.	Lower sulcus depth	Linear	5 mm	A larger value indicates protrusive lower lip.	Holdaway
49.	Lower lip to H-line	Linear	–1 to +2 mm	Positive values indicate protrusive lower lip; negative values indicate retrusive lower lip.	Holdaway
50.	Lower lip to E-plane	Linear	–2 ± 2 mm	Positive values indicate protrusive lips; negative values indicate retrusive lips.	Ricketts
51.	S-line to lower lip		In harmony	Deviation from harmony indicates lip imbalance.	Steiners
XI. Proportion analysis(Schwarz)					
52.	Anterior cranial base (N–S)	Linear	~71 mm	A longer base suggests prognathic tendency; a shorter base suggests retrognathic tendency.	Schwartz
53.	Ascending ramus height (Ar–Go)	Linear	~45 mm (♂), ~41 mm (♀)	A larger ramus indicates horizontal growth pattern with deep bite tendency; a shorter ramus indicates vertical growth pattern with open bite tendency.	Schwartz
54.	Maxillary base length (ANS–PNS)	Linear	~52 mm	Increased length suggests long maxilla; decreased length suggests short maxilla.	Schwartz
55.	Mandibular base length (Go–Gn)	Linear	~70 mm	Increased length suggests prognathic mandible; decreased length suggests retrognathic mandible.	Schwartz
56.	ACB : MB ratio	Ratio	20 : 21	Balanced cranial–mandibular proportion; altered ratio suggests skeletal disharmony.	Schwartz

57.	AR : MB ratio	Ratio	5 : 7	Balanced ramus–mandibular proportion; a lower ratio indicates vertical growth, a higher ratio indicates horizontal growth.	Schwartz
58.	MXB : MB ratio	Ratio	2 : 3	Balanced maxilla–mandible proportion; a lower ratio indicates mandibular prognathism, a higher ratio indicates maxillary excess.	Schwartz
	XII. Miscallaneous				
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SECTION-I

INTRODUCTION

1.1. Introduction

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'Cephalometrics is the language in which the poetry of the Orthodontic diagnosis and treatment planning is written' is a well-said statement by Cecil Steiner. Those interested in treating malocclusions should have a comprehensive understanding of cephalometrics and not be ignorant. Cephalometrics is a linguistic system that adheres to spelling, punctuation, and grammar rules, similar to any other language. Cephalometrics can provide crucial anatomical insights into the internal structures of the maxillofacial complex that cannot be obtained through other methods, such as two-dimensional radiological imaging or three-dimensional model analysis.

Cephalometrics was not exclusively employed by orthodontics; rather, it was introduced by physical anthropologists in the 18th century to compare the fossil remains of the cranium of early humans. Even though cephalometrics can be a valuable diagnostic and evaluative instrument for pedodontists, oral surgeons, and prosthodontists, it is evident that it has primarily been the domain of the orthodontic profession.

Salzmann eloquently quotes

"Cephalometrics includes measurements, description, and appraisal of the morphological configuration and growth changes in the skull by ascertaining the dimensions of lines, angles, and planes between anthropometric landmarks established by physical anthropologists and points selected by the orthodontist."

"The measurement of the head of a living subject from the bony landmarks located by palpation or pressing through the supra-adjacent tissue" - is called Cephalometry (Orthodontic Cephalometry, Athanasiou).

(Or)

"The measurement of the head from the shadows of bony and soft tissue landmarks on the radiographic image"- is known as Roentgenographic Cephalometry (Krogman and Sassouni, 1957).

I. History and development of cephalometry

This detailed historical exposition thoroughly examines the evolutionary journey of cephalometrics, spanning from its embryonic stages to its current status as a sophisticated practice in orthodontics. Throughout this narrative, significant figures and key milestones in the development of cephalometric techniques and analyses are highlighted, shedding light on the progression of this field.

The field of cephalometrics originated from the study of craniometry. For an extended period, anatomists and anthropologists were limited to quantifying the craniofacial dimensions of deceased persons' skulls. However, this was not feasible when dealing with real persons due to the inconsistent thickness of soft tissues, which compromised the precision of these measures. Radiography introduced a new approach that allowed researchers to indirectly and accurately measure the inside dimensions of the human skull with ease and consistency.

Various professions, including orthodontics, require a technique to examine the living human skull. The revelation of X-rays on November 8, 1895, by Sir William Conrad Roentgen proved to be a significant advancement in this field. The medical field has undergone a revolution, and dentistry is no exception to this transformation. The process of measuring the head by examining the shadows of bony and soft tissue landmarks on a radiographic picture was called "Roentgenographic Cephalometry" (Krogman and Sassouni, 1957). With the introduction of skull X-rays, the name "Roentgenocephalometrics" was coined to distinguish it from previous approaches that focused on measuring the outward physical characteristics of

the specimen. The term "cephalometrics" progressively replaced the cumbersome phrase used in dentistry literature for about a decade after introducing the x-ray-focused technique in the early 1930s. Although the old term had a different meaning, it was replaced due to its length.

1. Origins in Europe:

Cephalometrics took its initial steps into the realm of orthodontics through the pioneering efforts of Van Loon from Holland and Rudolph Schwarz from Switzerland. These visionaries applied anthropometric methodologies, paving the way for the integration of cephalometrics into orthodontic practices.

An esteemed European figure was Simon of Berlin, who pioneered the field of "Gnathostatics" and also created one of the earliest and most straightforward cephalometric analyses known as the "positional analysis". It was more commonly referred to as the "orbital canine law". He proposed that the orbital plane, which is a line drawn at a right angle to the Frankfort Horizontal plane and going through the orbitale, should intersect with the tip of the maxillary cuspid.

In 1922, Paccini authored a paper titled "Roentgen Ray Anthropometry of the skull" where he detailed a method for creating and assessing radiographs of both deceased and live individuals. Paccini's standardization of cephalometric radiographs and landmark identification marked a significant advancement, providing a framework for precise measurements and analysis.

Waldron's development of the early cephalometer represents a pivotal moment in the evolution of cephalometrics, showcasing early attempts at technological innovation to enhance accuracy and reliability. Later, it was modified in 1928 by Dewey and Reisner to create an early version of a cephalogram, which is a device used to support the head and position the film cassette.

2. American Innovations:

In the United States, pioneers like Milo Hellman and Atkinson played instrumental roles in advancing cephalometric techniques, laying the groundwork for future developments.

In 1931, two prominent practitioners, Broadbent in the U.S.A. and Hofrath in Germany, introduced a standardized cephalometric approach. This technique involved using a high-powered X-ray machine and a head holder known as a Cephalostat. In 1931, Broadbent published his standardized technique in the Angle Orthodontist, titled "A New X-Ray Technique and Its Application in Orthodontics." In Germany, during the same year, Hofrath wrote an essay titled "The Significance of Teleroentgenograms in Diagnosing Jaw Abnormalities."

Allen Brodie's integration of cephalometrics into orthodontic treatment assessment underscored the growing importance of this methodology in clinical practice.

3. Advancements and Standardization Efforts:

The contributions of Margolis, Tweed, and Highley introduced innovative cephalometric analyses, expanding the scope and utility of cephalometrics in orthodontic diagnosis and treatment planning.

Wylie's orthopedically oriented cephalometric analysis significantly differed from traditional approaches, emphasizing functional considerations in treatment planning.

Downs' comprehensive cephalometric analysis system provided clinicians with a systematic framework for evaluating craniofacial morphology and growth patterns. Thompson's research on mandibular function and positioning using cephalometrics further enhanced our understanding of craniofacial dynamics.

4. Standardization Initiatives:

The establishment of the American Association of Orthodontists (AAO) provided a platform for standardization efforts, with Phillip Adams leading initiatives to define cephalometric landmarks, techniques and their clinical applications.

Many analyses were introduced, further perplexing the orthodontists. Cephalometrics, as a language, was becoming muddled. Subsequently, the American Association of Orthodontists (AAO) emerged to rectify the prevailing state of uncertainty. In 1956, Phillip Adams was assigned the role of president of the special committee on roentgeno-cephalometrics to tackle the existing issues. The remaining jury members included Brodie, Highley, and Krogman, with Krogman as the chairman. In 1957, a three-day workshop was conducted. The workshop aimed to establish a formal definition of cephalometric points and planes, standardize methodologies, provide clarity in interpretation, and assess the practical application of these concepts.

Some agreements were reached at this workshop, which are summarized below.

- The desirable source/target distance should be standardized to Broadbent's original 5-ft. distance.
- The radiographs should be taken with the patient's face pointing to the operator's right so that the patient's left side of the face would be closest to the cassette.
- A magnification in the methods described above will be 5-7 percent and is acceptable.
- Even with the less sophisticated, 50 cephalograms can be taken without jeopardizing the patient's safety.

In July 1950, a second research workshop on radiographic cephalometrics was convened, with J.A. Salzmann leading the event. The workshop reached highly significant insights that had far-reaching repercussions. It was decided that the cephalometric analysis suitable for orthodontics would be one that did not demand substantial or very advanced training from the average clinician.

5. Further Advancements and Modern Era:

Cephalometrics was introduced to the wonders of computers in the 1960s, which coincided with the emergence of functional jaw orthopedics (FJO). 'Wits' appraisal, devised by Jacobson in 1975, was employed to evaluate the horizontal disharmony of the jaw.

Ricketts' emphasis on descriptive aspects and pioneering work in computerized cephalometric analysis marked a significant leap forward in the field. He also gave a revolutionary concept: computer-drawn individualized treatment goals known as "Visualized Treatment Objectives" (VTO).

Functional jaw orthopedics (FJO) emerged as a novel therapeutic approach, complementing traditional orthodontic methods.

Sassouni and McNamara's development of cephalometric analyses tailored to emerging therapeutic modalities showcased the adaptability and versatility of cephalometrics.

Bimler's emphasis on individualized standards and functional matrix theories reflected evolving paradigms in orthodontic treatment philosophy.

6. Future Prospects:

The integration of computer technology into cephalometric analysis represents a promising avenue for future advancements, with the potential for enhanced accuracy, efficiency, and predictive capabilities.

Ongoing research and innovation continue to shape the landscape of cephalometrics, with the potential to refine diagnostic techniques and treatment planning methodologies further.

The historical evolution of cephalometrics reflects a journey of continuous innovation and refinement, driven by the collective efforts of pioneering researchers and clinicians striving to enhance our understanding of craniofacial morphology and optimize patient care in orthodontics.

This book aims to provide a comprehensive overview of the fundamental concepts and analysis, thereby facilitating the comprehension of the most recent developments in the field.

II. Applications of cephalometrics

The following are some of the applications of cephalometrics in orthodontics:

1. **Diagnosis & treatment planning**

   a. Cephalometric films are used to evaluate and clarify the anatomic basis (skeletal, dental, and soft tissue structures of the craniofacial region) for a malocclusion, or in other words, it helps in the localization of malocclusion.
   b. Cephalometrics can be used to assess the absolute linear, angular, and spatial relationships:
      - Relationships between the cranium and jaws.
      - Relationships between the jaws themselves.
      - Relationship between different points within the same jaw.
      - Relationship of the incisors to the jaw bases and the planes of reference concerning axes and position.
      - Relationships of the facial thirds to each other.

   c. It helps in classification of the skeletal and dental abnormalities and also helps in establishing facial type.

   d. Functional analysis:
      - Cephalometrics can be used to assess the tongue position in the cranium and its relationship to the various dentoskeletal structures.
      - Cephalometrics can be used to assess the glide and rotatory movements in the closing of the mandible, which is termed functional analysis.
      - Cephalometrics can assess the patency of the airway.
      - It also assesses lip incompetency about incisal position and angulation in the craniofacial complex.

   e. Cephalometrics helps in planning treatment for an individual.

2. **Comparison using cephalometric analysis**

   - Serial cephalometric radiographs taken at intervals before, during, and after treatment can be superimposed to study changes in jaw and tooth positions retrospectively.
   - To compare the effect of two or more different mechanotherapeutic approaches on jaws and teeth.
   - Another way that radiographic cephalometrics is useful clinically is in recognizing and evaluating changes brought about by orthodontic treatment. Many clinicians reevaluate the case during treatment with cephalometrics to see if the treatment plan needs modification. The clinicians call it "re-analysis."

3. **Prediction of surgical treatment outcome**

   Cephalometrics helps in predicting the changes associated with surgical treatment.

4. **Cephalometrics and Growth**

   - To evaluate the remaining growth through the comparison of chronological and biological growth.
   - To determine the time frame for growth spurts.
   - To determine the direction of growth.
   - To assess whether interception is required during the mixed dentition period.
   - To assess mandibular morphology for growth signs.
   - To assess the growth rate through a comparison with standard measurements considering age and sex.
   - To predict growth which is complex, and even areas of quiescence will show change during orthodontic treatment with the following methods.

5. Cephalometrics is a valuable aid in research work involving the craniodentofacial region—the assessment of cranio-facial patterns between different races, age groups, sexes, and dental occlusion.

6. Cephalometric radiographs are not routinely taken as a screen for pathology, but the possibility of observing pathologic changes on these films should not be overlooked. Occasionally, previously unsuspected degenerative changes or anomalies in the cervical spine are revealed in a cephalometric radiograph, and sometimes other pathologic changes in the skull, jaws, or cranial base can be observed.

III. Types of Cephalograms

Cephalograms are of two types:

a. **Lateral cephalogram**: This provides a lateral view of the skull. It is taken with the head in a standardized reproducible position at a specified distance from the X-ray source. In normal lateral views of the skull, the source–film distance is 1 meter, but in cephalograms, it is 1.5–2 m.
b. **Frontal cephalogram**: This provides an anteroposterior view of the skull.

IV. Radiographic cephalometric unit

The cephalometric radiographs are taken using an apparatus that consists of an X-ray source and a head-holding device called a cephalostat.

Components of Cephalometer:

- X - Ray source
- Adjustable cephalostat
- Film cassette with intensifying screen (8" x10")
- Film cassette holder

All of these components are attached rigidly to each other at a fixed distance, thus creating the radiographic cephalometric unit.

Cephalostat: It is an instrument used for holding the patients head and the X-ray film in a desired relation to each other and to the central ray of the X-ray machine. The orbital pointer, two ear rods, and a nose clamp all together form the components of cephalostat.

According to Broadbent, the patient's head should be centered in the cephalostat with the superior borders of the external auditory meatus resting on the upper parts of the two ear rods. The midsagittal plane of the patient is vertical and perpendicular to the X-ray beam but parallel to the plane of the X-ray film which in turn is also perpendicular to the X-ray beam. The orbital pointer contacts the lowest point on the inferior bony border of the left orbit. The forehead/nose clamp was fixed at the root of the nose. The two ear rods prevent the movement of the head in the horizontal plane. Vertical stabilization of the head is brought about by an orbital pointer. The upper part of the face is supported by the forehead clamp, positioned at the nasion.

The orbital pointer and two ear rods make it possible to adjust the patient's head along Frankfort's Horizontal plane (line connecting the infraorbital rim and the superior border of the external auditory meatus). Standardized Frankfort plane is achieved by placing the infraorbital pointer at the patient's lowest point on the inferior bony border of the left orbit and adjusting the head vertically until the orbital pointer and the two ear rods are at the same plane. The distance between the X-ray source and the mid-sagittal plane of the patient is fixed at 5 feet (152.4 cm). Thus the equipment helps in standardizing the radiographs by use of constant head position and source film distance so that serial radiographs can be compared.

If the cephalogram must be produced in the natural head position, which represents the true horizontal plane, the patient should be standing up and should look directly in the reflection of his or her own eyes in a mirror held ahead in the middle of the cephalogram and the system has to be moved vertically. The ear-rods are not used for locking the patient's head into a fixed position but aid the median sagittal plane of the patient at a particular distance from the film plane, and to assist the patient in keeping his or her head in a correct position during exposure. However, the ear-rods should allow for small adjustments of the head and correct undesirable lateral tilt or rotation.

Adjustments of the cephalometer.

1. The patient is seated upright so that the right side faces the x-ray tube. The chair is elevated until the external acoustic meati or the auditory canals are at the height of the ear rods.
2. The operator places a hand on the patient's head while the ear rods are drawn into the ear canals.