

THE 20 PRINCIPLES OF THE ALEXANDER DISCIPLINE

R. G. “Wick” Alexander, DDS, MSD

Clinical Professor of Orthodontics
Baylor College of Dentistry
Dallas, Texas

Private Practice Limited to Orthodontics
Arlington, Texas



Quintessence Publishing Co, Inc

Chicago, Berlin, Tokyo, London, Paris, Milan, Barcelona,
Istanbul, São Paulo, Mumbai, Moscow, Prague, and Warsaw

Table of Contents

Dedication vii

Preface viii

Acknowledgments x

Principle 1	Effort Equals Results	1
Principle 2	There Are No Little Things	7
Principle 3	The KISS Principle	15
Principle 4	Establish Goals for Stability	21
Principle 5	Plan Your Work, Then Work Your Plan	35
Principle 6	Use Brackets Designed for Specific Prescriptions	49
Principle 7	Build Treatment into Bracket Placement	59
Principle 8	Exploit Growth to Obtain Predictable Orthopedic Correction	75
Principle 9	Establish Ideal Arch Form	97
Principle 10	Follow a Logical Archwire Sequence	107

- Principle 11** Consolidate Arches Early in Treatment 119
- Principle 12** Ensure Complete Bracket Engagement and Maintain Consolidation 127
- Principle 13** Let It Cook! 137
- Principle 14** Level the Arches and Open the Bite with Reverse-Curve Archwires 145
- Principle 15** Create Symmetry 153
- Principle 16** Use Intraoral Elastics to Coordinate the Arches 163
- Principle 17** Use Nonextraction Treatment When Possible 171
- Principle 18** Use Extraction Treatment When Necessary 183
- Principle 19** Careful Appliance Removal, Then Retention Will Improve Stability 203
- Principle 20** Create Compliance 213

Index 223

Dedication

It is with immense gratification that I dedicate this book to all those who have significantly influenced my life . . . beginning with my wife, Janna. Her loyalty and support have given me the security and confidence to chase my dreams. My parents, Jake and Gerry, and my siblings, C. Moody, Skip, and Kay, had so much significance in the early years. Brother Moody, being 4 years older, has been almost like a second father to me. Our children are the most incredible humans a person could imagine. Chuck and his wife Keri have three amazing children, Mac, Blake, and Kellyn. J. Moody and Emily are devoted parents to Hill, Wick, Avery, and Isabelle. Daughter Shanna and husband Luis have two fantastic sons, Mateo and Marco.

How could I forget the influence of my Spanish teacher, Miss Weir, my football coach, Coach Defee, or my speech teacher, Mr Flathers, at Amarillo High School? So many classmates at Texas Tech, University of Texas Dental Branch, and the orthodontic department and colleagues have touched my life in so many positive ways. Without Dr A.P. Westfall's support and encouragement in the orthodontic department, none of this would have ever happened.

In my first book I said that I would be ecstatic if my sons wanted to become orthodontists. Dreams do come true! In looking to the future, is it too much to wish that our grandchildren would do the same?

In his latest book *The 8th Habit* (Free Press, 2004), Stephen Covey focuses on an idea that the noblest endeavor a person can accomplish in life is to "find your voice." For me, that voice relates to my quest to find the way to routinely produce the highest-quality orthodontic results possible in a simple, routinely sequenced technique. Through years of trial and error, the Alexander Discipline evolved . . . and with it my voice. Covey then challenges us to "inspire others to find their voice." Thus the book.

This book is dedicated to you, the current and future orthodontists of the world. My hope is that its contents will reinforce the basic truisms you were taught and give you new ideas and concepts that will improve your finished results and long-term stability. I hope you enjoy reading my "voice." It is my great desire for the book to have significant meaning for you as you strive to find your own voice. You are the captain of your ship. Every orthodontic decision you make will influence your patient's outcome. You know what to do. May you have the basic desire, wisdom, and commitment to share your voice with your patients and do what must be done to produce those beautiful smiles. After all, that smile is your signature!

Preface

Someone once said that everyone should write a book at some point in their life. In 1987, I wrote a book entitled *The Alexander Discipline* that has now been translated into Japanese, Spanish, French, Italian, Portuguese, Mandarin, and Russian. Many of you are probably wondering why I have written another book on the same subject. Won't I just be rehashing the same information?

The answer is a resounding *no*. This is neither a replacement nor an update of my previous book, which described my clinical experience primarily in the form of anecdotal information. Since that time, many research studies have been completed (often using our patients) that position our technique on more solid ground. Is there a need for further explanation of this technique? Yes! This book builds upon that foundation.

Evidence-based dentistry is the conscientious use of the current best research and clinical proof in making decisions concerning the treatment of individual patients. In this and future volumes, much evidence-based knowledge will be presented that substantiates our anecdotal clinical experience. As time progresses, science continues to give us new opportunities to become more efficient in the treatment of our patients.

As the Alexander Discipline has evolved throughout the years, so has my thinking and, I hope, my ability to express my thoughts through the written word. Also, the constructive criticism offered by colleagues has been a great learning tool. Many years ago, a French orthodontist voiced one such criticism when he told a friend of mine that the Alexander Discipline had no principles, that it was just a set of brackets that did a great job of moving teeth. He believed these brackets could be used with any technique to move teeth more efficiently. Although it is true that the brackets are effective in that respect, this orthodontist failed to understand (or I failed to properly explain) the specific differences in sequencing of treatment, the use of continuous versus segmented archwires, and many other principles that are specifically discussed in this book.

As I pondered that statement, it became apparent that in my lectures I had not emphasized adequately the bedrock ideas and concepts that set our technique apart from others. So, after much thought and rearranging of ideas, our beginning course was reconstructed so as to emphasize the concepts that separate the Alexander Discipline from other techniques. The title of the course was changed from "A Comprehensive Exploration of the Alexander Discipline" to "The Principles of the Alexander Discipline."

This volume details the latest principles of the Alexander Discipline. Forthcoming volumes will be devoted to specific orthodontic problems and how they are addressed. By focusing on a specific area, we can give readers the knowledge they need to perform the "little things" necessary to complete treatment successfully. Selecting the topic for each chapter was rather obvious. Over the years as I have traveled the world, different groups have invited me to return on an annual basis and present "advanced" courses for those doctors who have already taken the Principles course. These lectures, which focus on specific details in treating a selected malocclusion, comprise the topic of each new chapter.

Evolution of the appliance

The original appliance was developed in 1977 and was called the Vari Simplex Discipline. Generation two, called the Mini Wick appliance, was developed in 1985. In this design, a stronger metal alloy was used, the brackets were reduced in size, and the wings were redesigned to be more efficient. In 1997, generation three evolved as the Alexander Signature appliance. As this book goes to press, a new self-ligating Alexander bracket is being evaluated.

In most chapters, patient records are used to illustrate the specific subjects being discussed. This allows readers to observe the treatment procedures and results in a variety of malocclusions. Of course, some cases demonstrate more than one subject, and this is noted in the text.

John Cotton Dana boldly declared "Who dares to teach must never cease to learn." Over the years I have reflected upon my professional life and questioned myself, asking, "Why me, Lord?" A person of average intelligence, I consider my greatest talent to be an irrepressible curiosity. I also need to make things simple, and I guess I have an innate drive or persistence to make things better. Calvin Coolidge said it best: "Nothing in the world can take the place of persistence. Talents will not; nothing is more common than unsuccessful people with talent. Genius will not; unrewarded genius is almost a proverb. Education will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent." It has been a combination of curiosity, persistence, and the help of many people along the way that has allowed me the opportunity to create this technique and share it with so many over the years.

Philosophy of orthodontics

The turn of the century has brought forth a new concept in the delivery of orthodontic treatment. It seems to me that some are interested in changing our specialty from a profession to a business, possibly because of the changes that have taken place in medicine. Obviously in private practice a profit must be generated if the doors are to stay open. Traditionally this has been accomplished quite well by charging a reasonable fee for services and doing what is necessary to ensure that the patient is afforded the highest-quality treatment possible. If our specialty as we know it today is to survive, continued emphasis must be placed on quality of care.

Of course, becoming more “efficient” in our delivery system also is important; I have always sought to improve the efficiency of our technique. The disconcerting problem is that some strategies are used for “efficiency” and are not necessarily in the best interests of the patient. For example, I cannot count the number of times I have heard a doctor say, “I can’t get them to wear the headgear, so I will use a functional appliance.” By putting a little more effort into communicating and educating all involved, it is possible that the patient will surprise you and do what is best.

Seeing patients less frequently is a concept I have endorsed for years. The principle “let it cook” speaks to that issue. Monitoring patients every 3 months during active treatment, however, may be unrealistic in many cases. Any enduring belief must be built on a solid foundation—certain “truths” that have been tested and proven by time and experience. In the Alexander Discipline, certain principles give this technique its uniqueness.

The first three principles focus on the philosophical nature and the attitudinal approach to the delivery of the discipline. One of the original goals of the technique is to make treatment easy and more comfortable for the patient. For any technique in orthodontics to be successful, the patient must be involved in the procedures. Even though some appliances are said to be “noncompliant,” the reality is that there is no such thing possible. Each patient must be willing to keep his or her teeth clean, take care of the appliances, watch what they eat, come to the appointments. Allowing patients to become a partner in the treatment procedures not only gives them some ownership in the process but ensures that the results will reach a higher level.

Patient compliance is critical to the success in this technique. Too often, techniques focus only on the mechanics of treatment. They are important, of course, but mechanics alone will not produce a successful result without patient cooperation. In orthodontic education, perhaps the forgotten skill is teaching the student to motivate the patient. When the need for this skill is understood, the doctor accepts the responsibility to learn techniques that

enhance his or her ability to motivate patients while producing high-quality results.

My older brother and titular head of our orthodontic family, C. Moody Alexander, was chairman of the Baylor orthodontics department from 1975 to 1985. He taught me so many things over the years, but one of my favorites is his philosophy of teaching—that learning should be fun. I completely agree.

Legacy

I have known some professionals who spent their lives learning and used their talents to help their fellow man and woman; when they retired, all of the knowledge and experience they had gathered during their lifetime of work went with them, leaving a deep hole of emptiness. Another person then had the difficult task of filling those shoes and “reinventing the wheel.” A few years later, by trial and error, this person finally reached the level of the original person. What a terrible waste of time and talent!

Orthodontics in the Alexander family began with my older brother, C. Moody Alexander. If he had chosen another profession, it is very likely that I would never have been an orthodontist. He has always been my guide and inspiration. His son, Cliff, followed in his father’s footsteps and is a major contributor to our philosophy.

Among a father’s greatest blessings is to have his children follow him in his work. The greatest compliment I have received is that both sons have chosen the same specialty as their father. (I am sad to say that my daughter, Shanna, chose hotel management as her career and has been very successful.) But my goal as a father and a teacher has been to teach my sons Chuck and J. Moody and my nephew Cliff everything I have learned over the past four decades so they could reach my level early in their careers and continue to grow thereafter. I can now say that this goal has been achieved because they are better orthodontists than their father and uncle, and what a joy that is!

Actually, this is my goal for every orthodontist who is interested in our concept of orthodontics. And I can say that many of my students who have adopted and practice our discipline, both from Baylor and around the world, are also better orthodontists than me. Every teacher’s goal should be for the student to exceed the level of the teacher.

With these thoughts in mind, I now present to you the second book on the Alexander Discipline. As knowledge and technology change, so will our technique. There is no finish line. Robert Schuller once said, “We go from peak to peak.” We must climb to the top of the peak of the mountain before we can see or peek at the peaks of all those other mountains out there. Enjoy the journey!

Acknowledgments

This book would never have been published without the hard work and dedication of my staff. Dr Elisa Espinas-San Juan, my associate for orthodontic research, lectures, and publications, spent untold hours and days gathering photos, creating graphics, and helping me structure the chapters. Becky Davis, my administrative assistant, “kept the wheels turning” by coordinating completion of the manuscript. These two wonderful people made dedicated commitments to see this project through.

Dr Michael Swartz’s knowledge and talents were invaluable in assisting me with editing and proofreading the manuscript and creating many of the graphic illustrations. Thanks, Mike, for your help and friendship dating back to our early days with Ormco.

So many mentors and friends have helped shape this journey I have been privileged to travel. Although I will surely leave out names of influential people who helped along the way, I will attempt to thank some of those who supported and inspired me.

A group of people who had tremendous influence on me throughout my career were my teachers, friends, and associates in orthodontics: Jim Reynolds, A.P. Westfall, Bob Gaylord, Howard Lang, Jay Barnett, John Lindquist, Jim Boley, Bill Robinson, Robert Orr, Tucker Haltom, Peter Buschang, Buzz Behrents, Jerry English, George Cisneros, Olivier Nicolay, Elliott Moskowitz, Brian Preston.

Our American study club has been together for over 30 years. The support and guidance of these men and women have been so rewarding: Alan Akridge, Dean Baesal, Mike Cherre, Joe Crain, Gayle Glenn, Lisa King, Chuck Pfister, Larry Roberts, and Bob Smith.

Asking the clinical staff to interrupt their routine patient schedule to take specific photos or look for a particular case can be very disrupting. So special thanks goes to clinical assistants Ellie Oginski and Misty Johnson for their efforts and positive attitudes while helping us find what we needed. Previous assistants who also were very helpful include Gerrie Smith, Melanie Lashley, and Yalonda Klein. Former front office staff who still contribute to our practice are Guelda Middleton and Brenda Horton.

“No man is an Island.” Early in my career I began hiring recent orthodontic graduates to work in my office. Almost every case that has been treated in this office has been assisted by one of these doctors. In addition to helping me tremendously, they also learned the fundamentals of our technique and became very successful doctors in their own clinics.

Over the years we have hosted 10 international doctors for 1-year internships to learn the day-to-day procedures in producing our results.

Leaders in our international study clubs and other influential friends include Crazy Horse-Yasuhiko Asai, Isao Koyama, Shigeki Sakuraoka, Yasuko Kuroda, Chiori Hashiba, Miho Imamura, Haruya Ogawa, Toshio Deguchi, Remo Benedetti, Leonella Caliani, Maurizio Azzolina, Barbara Lapini, Florian Faessler, Kathrin Faessler, Iris Frasch, Peter Schopf, Astrid Heider, Ingrid Rudzki-Janson, Dominique Schreiber, Edith Fessel, Philippe Delo, Ann Singer, Laura Gonzalvo, Alain Decker, Werner Fiederer, Sylvie Pourret, Isabelle Soufflot, Patrice Yan Luk, Sergey Gerasimov, Prof Fevralina Khoroshilkina, Evgeniy Zubrilin, Urban Hagg, Song Wei, Prof Minkui Fu, Hong He, Feng Xue, Joung-Lin Liaw, Morgan Shen, Young-Chel Park, Schwan Somsiri, Marko Perkovic, Ali Ouazzani, Amina Elomrani, Anna Orzelska, Olga Kaska, Morris Strauss, Rafi Romano, M.K. Prakash, Stifanos Karakousoglou, Ivan Gorylov, Vessela Djoneva, Tatyana Karagenska, Andres Vegh, Gabriella Borsos, Claudia Corega, Martin Jenne, Lars Medin, Nazan Kucukkeles, Yildiz Ozturk, Joel Martins, Lidia Martins, Graca Guimaraes, Carmen Luce Rocha Lune, Emilia Kobayashi, De la Cruz, Carlos Calva, Jorge Franco, Numa Escobar, Miguel Sanchez Herrera, Hong He, Melina Tjoe, Catherine Veneracion-Juliano, Julio Saldarriaga, Constanza Patino, Luis Batres, Elizabeth Cortez, Billy Wiltshire, Carlos Cabellero, Fouad Sidawi, Gene Gottlieb, and Larry Wolford.

More than 50 graduate students used my diagnostic records for their research studies. Not only did they fulfill their requirements, they changed my anecdotal opinions to evidence-based facts, and for that I am grateful.

Technical and professional support from Quintessence was provided by Lisa Bywaters, Senior Editor, and Patrick Penney, Production Editor. After much “trial and tribulation,” these two very professional veterans were able to put it all together.

A special word of thanks to my sons, Chuck, who spent 6 years working in my office before moving to Colorado, and Moody, who has taken over my practice in Arlington, Texas. Each of them has contributed cases shown in this book. But more significantly, I am so proud that they have taken my technique and philosophy and continued to make it even better. With them and with all students, my goal has been to teach them everything I know. I can truly say that now they are both better orthodontists than I.

8 · Exploit Growth to Obtain Predictable Orthopedic Correction

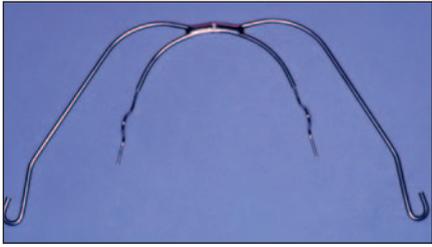


Fig 8-4 The most effective and inexpensive Class II orthopedic appliance is the facebow.

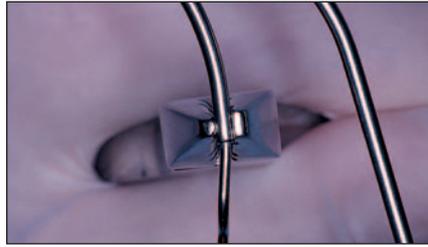


Fig 8-5 Initially, the inner bow is adjusted to be similar to the maxillary arch form template.



Fig 8-6 The distal end of the expanded inner bow is bent to be parallel to the headgear tube.

The facebow (Fig 8-4) is the appliance of choice for the correction of Class II skeletal malocclusions because it can affect growth in all three dimensions: control of sagittal growth requires cervical-pull headgear; in patients with vertical growth patterns a high-pull vector is used; and the transverse dimension can be controlled and improved by inner facebow adjustments. In addition, as mentioned previously, the reciprocal force is applied to the back of the neck or head, thus eliminating the negative reaction on the mandibular anterior teeth.

The keys to success in facebow therapy include proper adjustment of the facebow and the direction and amount of force, along with patient growth and compliance (number of hours worn).

Direction of pull

If the mandibular plane angle (sella-nasion–mandibular plane) is less than 36 degrees, the directional pull is cervical (see Fig 5-3). If the mandibular plane angle is 36 to 42 degrees, the directional pull is combination (see Fig 5-5). If the mandibular plane angle is greater than 42 degrees, the directional pull is high (see Fig 5-7).

Amount of force

The initial force is 8 oz (227 g). Subsequently, a force of 16 oz (454 g) is applied.

Hours worn

If point A–nasion–point B (ANB) is less than 3 degrees, the patient is instructed to wear the facebow for 8 hours daily

(nighttime only). If ANB is from 3 to 5 degrees, the patient is instructed to wear the facebow 10 hours per day. If ANB is greater than 5 degrees, the patient is instructed to wear the facebow 12 hours per day.

Facebow adjustments

To achieve success with facebow treatment, this appliance must be adjusted properly.

Transverse adjustment

In the transverse dimension, an inner bow expansion of approximately 4 mm should be maintained (Figs 8-5 and 8-6).

Molar rotation

The distal end of the inner bow, the portion entering into the headgear tube, must be adjusted to insert passively into the headgear tube. As the molars rotate, this adjustment must be repeated at each appointment (Fig 8-7).

Sagittal adjustment

The anteroposterior position of the inner bow–outer bow connection is just anterior to the lips at rest (Fig 8-8). This positioning is accomplished by enlarging or constricting the adjustment loop on the inner bow (Fig 8-9).

Vertical adjustment

Vertically, the facebow is positioned at the center of the lips (see Fig 8-8). This is accomplished by bending the inner bow wire, where it enters the headgear tube, either up or down as necessary (see Fig 8-6). After the facebow is attached, the vertical position of the facebow should not change. Any significant rotation of the outer bow when connected to the strap indicates that a rotational moment is being applied.



Fig 8-7 Example of expanded inner bow parallel to headgear tube.

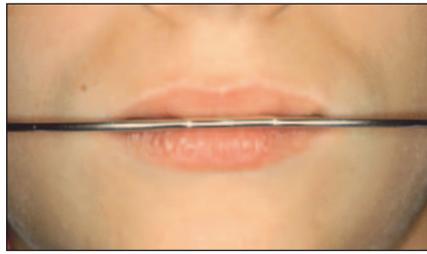


Fig 8-8 The connection of the inner bow–outer bow should be positioned just beyond the lips closure and balanced between the upper and lower lips.

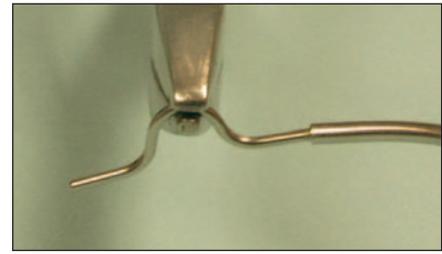
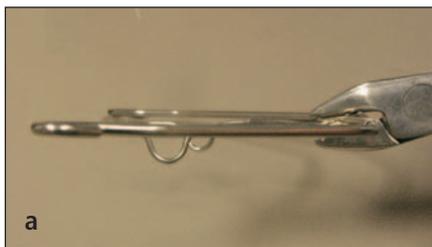


Fig 8-9 The position of the inner bow–outer bow connection can be changed by expanding or constricting the adjustment loop.



Figs 8-10a and 8-10b Vertical growth can be controlled by keeping the outer bow parallel to the occlusal plane.



Fig 8-11 The outer bow is adjusted to contour around the cheeks when the neck strap is attached.

Fig 8-12 The outer bow forces the patient to sleep on the back of the head because it would press against the cheek if the patient slept on the side of the face. Since most growth takes place at night, the facebow facilitates more symmetrical mandibular growth.



It is very important that the outer bow is parallel to the inner bow and parallel to the occlusal plane (Fig 8-10). If the force is directed in this manner, the vertical dimension will be controlled. The outer bows are adjusted so that they will be just lateral to the cheeks when the extraoral force is applied (Fig 8-11).

Although this is only an intuitive statement, I believe that the outer bows of the facebow force the patient to sleep on the back of their head rather than on the side of

their face. This allows the mandible to grow without the application of any abnormal forces, thus encouraging symmetric growth (Fig 8-12).

Molar vertical control

In a high-angle case, it is critical that the facebow have no extrusive force on the molars. This is accomplished by raising the outer bow 20 to 45 degrees above the inner bow. The point of attachment of the headgear to the outer bow

Establish Ideal Arch Form

“All arch forms are perfectly aligned to get the results they get.”

— Unknown

For the first 20 years of my practice, all archwires were formed by hand from basic, single-sized arch “blanks.” These standard arch blanks were preformed from canine-to-canine only and then extended posteriorly in a straight line, with no contours in the buccal segments. Each archwire was then individually adjusted to conform to the arch form desired for each patient.

In 1982, McKelvain¹ reported on the measurement of 102 maxillary and mandibular, custom-formed, 0.017 × 0.025-inch stainless steel finishing archwires used in patients treated in my office. A composite arch form derived from the 102 custom-formed archwires was created and manufactured beginning in 1984. This template has been used in our office ever since (Fig 9-1).

The research on mandibular arch forms by Felton et al² is considered a landmark study on the subject. When 17 commercially available arch form templates were compared, it was determined that 50% of the arch forms studied approximated those of the Vari-Simplex Discipline (Ormco). However, “changes in arch form with treatment frequently were not stable; almost 70% of cases (30 Class I and 30 Class II, nonextraction cases) showed significant long-term posttreatment changes.”²

An arch form study by Lapointe et al,³ using patient records from my office, concluded that, “the orthodontist

has only a limited influence on arch form during and after treatment.” These cases were all Class I, extraction and nonextraction. No expansion therapy was used on any patient. These 39 patients had been out of treatment an average of 15 years.

Determination of the Ideal Arch Form

Based on the studies of patients treated in my office¹ and the long-term stability of these cases, I have come to the following conclusions about ideal arch form.

First, the anterior segment of any arch form should be dictated by the mandibular intercanine width (Fig 9-2) and the position of the mandibular incisors (Fig 9-3). Unless the canines have erupted abnormally lingually, the intercanine width should be expanded less than 1 mm.

Second, the mandibular incisors should be kept in an upright position. This anterior segment of the mandibular arch form was taught by Tweed with the Bonwell-Hawley arch form. Because little variation in arch form can take place

Principle 9 Case Study



Fig 9-11 Pretreatment facial views, age 12 years, 6 months. (a) Soft tissue profile reveals mandibular deficiency. (b) Frontal view shows a slight mandibular shift to the right. (c) Smile line exposes half of a clinical crown.



Fig 9-12 Pretreatment intraoral views. (a) Right buccal segment reveals an end-on occlusion. (b) Significant overbite 5 mm, overjet 7 mm, and midline shift. (c) Left buccal segment also reveals an end-on occlusion.



Figs 9-13a and 9-13b Pretreatment maxillary occlusal view shows crowding and a broad arch form. Mandibular arch shows 6 mm crowding.

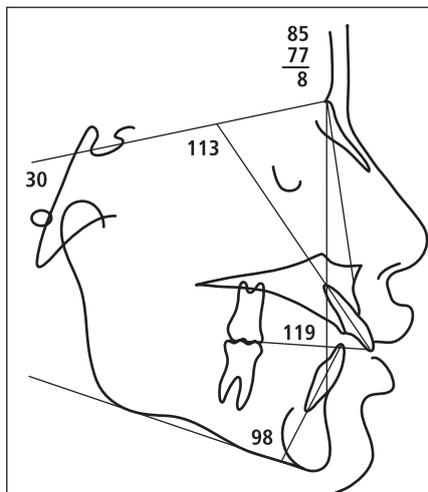


Fig 9-14 Pretreatment cephalometric tracing shows skeletal Class II division I malocclusion, normal SN-MP. Goals: reduce ANB and U1-SN; maintain SN-MP and IMPA.



Fig 9-15 Panoramic radiograph indicates posterior as well as anterior crowding. The developing third molars also are visible.

Principle 9 Case Study



Figs 9-16a to 9-16c Five-month progress views showing use of 0.016-inch NiTi archwires to align and level anterior teeth. The patient is also sleeping in cervical facebow.



Figs 9-17a to 9-17c Eight-month progress views showing use of 0.016-inch SS maxillary archwire-omega loops, curve of Spee, tied back archwire; retraction of canines with power chains; use of 0.016-inch SS mandibular archwire to remove rotations.



Figs 9-18a to 9-18c Thirteen-month progress views showing the use of closing loop archwires in each arch.

Table 9-1 Archwire sequence

Archwire	Duration (months)
Maxillary	
1. 0.016 NiTi (2)	6
2. 0.016 SS	6
3. 18 × 25 SS	6
Closing Loop	
4. 17 × 25 SS	8
Active treatment time:	26 months
Mandibular	
None	8
1. 0.016 NiTi	2
2. 0.16 × 22 SS	5
Closing Loop	
3. 16 × 22 SS	3
4. 17 × 25 SS	8
Active treatment time:	18 months



Fig 9-19 Eight-month occlusal views. (a) Ovoid arch form; canine retraction. (b) Extraction space almost closed due to "driftodontics." Brackets placed at 8 months.



Fig 9-20 Thirteen-month occlusal views. (a) Retracting incisors with closing loops. (b) Final space closure with closing loops.