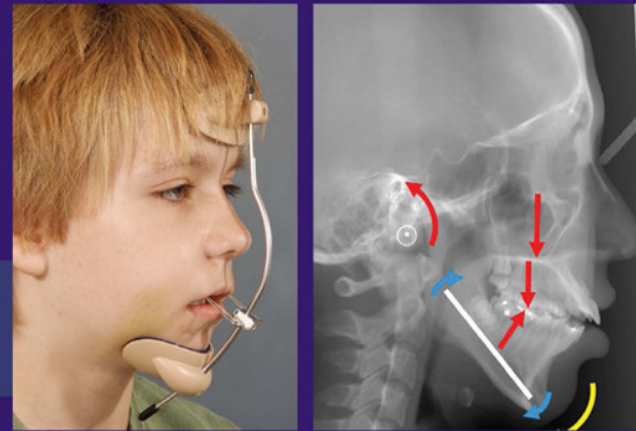
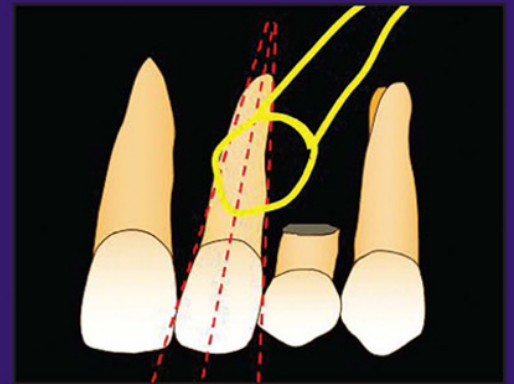


# Practical Early Orthodontic Treatment

A Case-Based Review



Thomas E. Southard  
Steven D. Marshall  
Laura L. Bonner  
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WILEY Blackwell



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## Preface

Welcome to the world of early orthodontic treatment, an exciting and professionally satisfying area of our specialty. Every orthodontist should be proficient in this area: in assessing childhood malocclusions and dentofacial deformities, making appropriate decisions when dealing with these conditions, and providing superlative care based upon these decisions.

Many orthodontic residency programs provide first-rate early treatment education. Unfortunately, others do not. When Steve, Laura, Kyungsup, and I began practicing after graduation, we quickly realized that most patient consultations were for children, that the early treatment education we had received during our residencies was lacking, and that we were often ill-prepared to answer simple consultation questions, such as:

- “Should I begin treatment on this child *now*, or should I recall the child in six to twelve months?”
- “If I choose to treat now, what are my treatment goals? What treatment should I provide to achieve those goals? What treatment should wait, and when should I provide treatment?”
- “If I choose *not* to treat this child now, what harm could result?”

We wrote this book so that you will be better prepared than we were. It will provide you with a solid foundation in the early management of malocclusions. This is the book we wish we had studied as residents.

Dr. Shin and I spoke at the American Association of Orthodontists’ annual meeting on the topic “Practical Early Treatment.” At the conclusion of our talk, an audience member asked, “Why *early* treatment? Can’t I just treat patients later, comprehensively, after all their permanent teeth erupt?” The short answer is that you can wait until all permanent teeth erupt, but the patient may be harmed by waiting. For example, if the ectopic eruption of maxillary permanent canines is not corrected early, then resorption of adjacent teeth roots may occur. Further, you may increase the complexity of the case by waiting until all

permanent teeth erupt. If you do not begin early orthopedics in certain patients, you may miss an opportunity to modify a patient’s growth to their advantage. However, there are times when you can (and should) wait to begin treatment until all permanent teeth erupt. One purpose of this textbook is to provide you with the knowledge needed to determine when you should initiate early orthodontic treatment and when you can wait.

This book is divided into six chapters: Foundations, Crowding, Eruption Problems/Missing Succedaneous Teeth/First Permanent Molar Extractions, Anteroposterior Problems, Vertical Problems, and Transverse Problems, as well as an Appendix. In the Foundations chapter, we provide an overview of general early treatment principles along with important craniofacial growth and development concepts. In the Crowding chapter, we provide overall treatment principles along with specific diagnostic and treatment recommendations in the Introduction. The cases that follow in the Crowding chapter encompass a wide range of crowded patients illustrating the application of these principles and recommendations. Some consultation patients are presented with minimal records, and you are asked to assess the patient and provide recommendations during one visit. Other patients are presented with full records and you are asked to use these records to treat the patient from initial assessment through completion of early (and comprehensive) treatment. The organization of this chapter is repeated for subsequent chapters.

The Appendix presents a cephalometric analysis primer, the Iowa AP Classification Primer, useful tables, and abbreviations.

We wish to note that every case we present was painstakingly chosen from a cumulative practice experience of over seventy years with the intent of illustrating principles by applying those principles to a broad range of problems. In summary, you will become intimately involved in the diagnosis and treatment planning of more than 50 patients early in their development.

Like our previous book (*Orthodontics in the Vertical Dimension: A Case-Based Review*. Wiley Blackwell, 2015), the format of this book is based on a question-answer style of teaching – as experienced during an orthodontic residency. This question-answer format keeps you intellectually involved, encourages critical thinking, offers you the opportunity to reflect on our questions and your answers, and gauges the progress of your understanding. Using this format, we will coach you to address a spectrum of challenging clinical problems and formulate appropriate treatment decisions. To grasp the principles upon which we focus, we recommend that you study each case at one sitting, from beginning to end. Carefully think through the answer to each question we present (ideally, by writing down your answer), and make the best decision you can. You should do this *before* you refer to the answer we provide. Answer each question as thoughtfully as you would if you were with a patient.

After you have finished studying one case, go back and review the questions you were not comfortable with. Try answering them again. Then, *close your eyes*. Visualize a child coming to you with a condition similar to the one you just studied. Visualize how you would recommend treating that child. Finally, return to those same questions a week or so later. Your orthodontic diagnostic, treatment planning, and in-treatment decision-making abilities will strengthen in direct proportion to your efforts to work through each problem presented.

The practice of orthodontics and dentofacial orthopedics is a cognitive discipline which requires exceptional intelligence, the ability to apply the best science combined with practical principles of growth and development, anatomy, physiology, diagnosis, and biomechanics, and an uncompromising desire to care for the patient. Every patient is different, and every patient's individual response to treatment will vary. However, the principles established in this text are applicable for every child and will serve you over a lifetime of clinical practice.

These principles are emphasized and applied repeatedly throughout this book – just as during a residency. The principles will instill in you patterns of analysis and habits of rational decision making. You will learn to apply these principles over a diverse patient population until they become an inherent part of your thought processes in daily practice.

*"Repetitio mater studiorum est."  
(Repetition is the mother of all learning.)*

The answers we provide for the cases presented are based upon our many years of teaching, literature review, and clinical experience at the University of Iowa and in private practice. This does not mean, however, that our answers are necessarily, or always, correct. Everything taught in our specialty must be constantly challenged and questioned. If our ideas cannot withstand the rigor of scrutiny and the test of time, then we must modify our position. If you disagree with concepts in this text, please discuss them with your colleagues, attending faculty, or us. Constructive dialogue makes us better orthodontists, results in better care for our patients, and strengthens our specialty.

Included in this text are important references for many clinical and scientific concepts, but this book was not written as a systematic review reference source. The treatment principles contained herein will be valid for your lifetime, but the specific scientific and clinical study references may evolve over the years.

We wish to acknowledge the diagnostic skill, treatment outcomes, and patient care provided by Dr. Karin A. Southard who kindly allowed us to include many of her cases. Karin is a clinician's clinician and an educator's educator. We thank her for her teaching and her many contributions to excellent patient care. We wish to thank Dr. Michael L. Swartz for his permission to use Orthodontic Clipart in developing many of the illustrations in this text, and Ms. Chris White for her thorough review and many insightful suggestions.

Our goal is your goal – we want you to become the best orthodontist you can be. As teachers, Steve, Laura, Kyungsup, and I always strive to help you become a better orthodontist than we are. We experience no greater professional joy than when our students rise above us.

From conception to completion, we invested seven years in composing this textbook. If you learn one thing, our years of preparation and writing will have been worthwhile.

This book is dedicated to you, the doctor who strives daily to become proficient in the art and science of early orthodontic treatment, and who endeavors to provide uncompromising care to his or her patients. Doctor, we salute you.

## About the Companion Website

Don't forget to visit the companion website for this book:

[www.wiley.com/go/southard/practical](http://www.wiley.com/go/southard/practical)



It contains:

- a 200-slide PowerPoint presentation covering the principles
- video clips of lectures using a question-and-answer format



## 1

## Foundations

### General Principles

The problems you will face in treating early malocclusions vary widely and are ever-changing. However, the principles presented in this section are enduring and will serve as your foundation for dealing with those problems.

**Q:** What is early orthodontic treatment?

**A:** Early orthodontic treatment (early limited treatment, early interceptive treatment, or Phase I treatment) is the treatment provided during the *primary or mixed dentition* stages of dental development. Comprehensive orthodontic treatment (Phase II treatment) is provided in the adult dentition.

**Q:** What is the goal of early orthodontic treatment?

**A:** The goal is to correct developing problems to get the patient *back on track (back to normal) for their stage of development*. This includes treatment to prevent complications, reduce future comprehensive treatment complexity, and reduce/eliminate unknowns.

**Q:** Can you provide examples of early treatment to prevent complications or reduce future treatment complexity?

**A:** Early treatment can prevent root resorption or tooth impaction in some cases of ectopic tooth eruption. Early treatment can eliminate the need for permanent tooth extractions or orthognathic surgery in some cases of skeletal discrepancies.

**Q:** Can you provide examples of unknowns which can be reduced/eliminated with early treatment? Why are reducing/eliminating unknowns important?

**A:** Examples of unknowns include:

- Magnitude and direction of future jaw growth
- Undetected CR-CO shifts
- Patient cooperation with headgears, functional appliances, elastics, hygiene, etc.
- Ectopic tooth eruption

Reducing/eliminating unknowns enables the orthodontist to more effectively plan final treatment and achieve desired outcomes. Let's consider one quick example. Assume that a child presents to you in the late mixed dentition with a bilateral Class II molar relationship of 4 mm. Further assume that, after careful analysis, you settle upon two treatment options – either Class II orthopedics or extraction of maxillary first premolars (masking the underlying skeletal discrepancy). It would be prudent to reduce unknowns first by *attempting* Class II orthopedics and monitor the response you get, before you decide on a final treatment plan (finish with orthopedics or treat irreversibly with extractions).

*Key principle:* After you have defined the patient problems you hope to address, always force yourself to answer the following questions: *What unknowns are present in treating this patient, and what unknowns should I eliminate before I define my final treatment plan or do something irreversible?*

Always explain unknowns to patients and parents. Informing them early of uncertainties in your plan will foster a smooth transition if you later need to modify your treatment plan due to unanticipated growth or treatment response. Always reduce/eliminate unknowns before committing to irreversible treatment. To do otherwise is to gamble on your patient's outcome.

Finally, many unknowns exist for each patient. We will highlight only the most pertinent and important.

**Q:** Another principle we will emphasize is this: Proper diagnosis should identify the patient's *primary problems* in each dimension (anteroposterior, vertical, transverse) plus other major problems (e.g. crowding, ectopic tooth eruption, thin periodontal biotype). Why is this important?

**A:** These are the problems which will impact your treatment goals and treatment outcome the most. Some will require early treatment. Others are best managed later in development. You must identify primary problems in your diagnosis and develop a treatment plan to address them. During the time you manage each early treatment patient, make it a point to stay focused on the major problems you are facing. If you focus on major problems, then you can gradually reduce these problems and next focus on lesser problems. If you fail to focus on major problems, then the major problems could remain or worsen and detract from the desired outcome.

During your initial patient evaluation, and *as you examine the patient at each appointment*, always ask yourself: "What are this patient's primary anteroposterior, vertical, and transverse problems (plus other major problems), and what is my plan to address these problems?" Then, regularly reassess these major problems as you get the child back on track.

**Q:** Is early treatment beneficial?

**A:** It can be. A recent study was conducted with 300 children (mean age nine years) who received treatment via numerous treatment modalities, including 2x4 fixed appliances, cervical or high-pull headgears (CPHG, HPHG), reverse pull headgears (RPHG), functional appliances, lip bumpers, lower lingual holding arches (LLHAs), and serial extractions. Significant reductions in the American Board of Orthodontics Discrepancy Index were observed [1].

Of course, this does not mean that early treatment is always beneficial. Benefit is maximized when diagnosis is accurate and appropriate treatment is applied. In this book, we will illustrate conditions where early treatment should be considered.

**Q:** Can early treatment add to *total* treatment time?

**A:** Yes. You must weigh the benefits of early treatment against the cost – including the possible increase in total treatment time. Remember, the cost can be influenced by unknowns that may be revealed after you begin

treatment (e.g. aberrant growth or poor compliance). Reducing unknowns is key to weighing benefit vs. cost.

**Q:** An orthodontist in your study club complains, "I used to perform a lot of early treatment. I do a lot less now because those cases seemed to drag on and on. I ended up doing most of the treatment in the permanent dentition anyway, and the children complained that they were in braces forever!" How would you respond?

**A:** We think this orthodontist makes a good point. *Early orthodontic treatment should address very specific problems, with a clearly defined endpoint.* With the exception of orthopedics for anteroposterior (and open bite) skeletal discrepancies, early treatment should generally begin and end within six to nine months, not drag on for years and years.

Let's consider a few short examples. Assume a healthy eight-year-old boy presents in the early mixed dentition with a Class I molar relationship and displaying one maxillary central incisor tipped lingually and in traumatic edge-to-edge occlusion with a mandibular incisor (incisal edge wear noted). A reasonable early treatment of short duration (3–4 months) would be to move the maxillary incisor labially out of traumatic edge-to-edge occlusion, and then place the patient in a clear maxillary retainer. Correcting the incisor trauma will get the patient *back on track* for his stage of development, and eliminating the incisor trauma has a *clearly defined endpoint*.

Now assume another healthy eight-year-old boy presents in the early mixed dentition and displays a bilateral 5 mm Class II molar relationship secondary to mandibular skeletal hypoplasia. Here, it may be best *not* to begin early treatment for the Class II problem (Class II orthopedics) *unless the boy demonstrates good statural growth velocity*. Why is this prudent? If growth velocity is slow, then a defined endpoint is less clear and years could be added to his total treatment time. All prospective clinical trials report no advantage in attempting Class II correction in the early mixed dentition (except for possible incisal trauma reduction) [2]. Therefore, unless you can reduce this unknown and establish that your patient has good growth velocity, it may be best to wait to begin treatment.

Our point is that there are many times when you should begin early treatment. There are also many times when you should not begin early treatment. One of the purposes of this text is to provide you with a foundation in making the decision to begin or recall.



**Q:** What questions should you ask yourself at every early treatment consultation?

**A:** Do I need to do anything now? *What harm will come if I simply monitor the patient at this time and recall in six to twelve months?* If the answer to your question is *no harm*, then your best treatment may be to monitor only and re-evaluate later.

**Q:** Can you list specific conditions that might warrant early orthodontic treatment?

**A:** We already mentioned incisor trauma due to edge-to-edge relationships or anterior crossbite relationships. Other conditions include dental crowding, eruption problems, excess overjet, skeletal Class II malocclusions in the late mixed dentition (or early mixed dentition if the patient exhibits good statural growth velocity), skeletal Class III malocclusions in the early or late mixed dentition (depending upon severity), deep bites with palatal incisor impingement/pain/tissue trauma upon closing, dental anterior open bites, skeletal anterior open bites (depending upon severity), and posterior crossbites with lateral shifts.

Let's invite our first patient in for a consultation and make a decision whether to provide early treatment or recall. Theo (Figure 1.1) is an eight-year-old boy who presents to us with his parents' chief complaint, "Theo has a cross bite that we want corrected." Past medical history (PMH) and Past dental history (PDH) are within the range of normal (WRN). Temporomandibular joint (TMJs) are WRN, and CR = CO.

**Q:** What do you notice about the position of the permanent maxillary canines in the lateral cephalometric radiograph (Figure 1.2)?

**A:** There appears to be a slight difference in their anteroposterior and vertical position.

**Q:** What could this be due to?

**A:** Lack of perfect superimposition of bilateral paired structures on a cephalometric radiograph can be due to:

- The effect of radiographic enlargement on bilateral structures
- Inaccurate patient positioning due to misalignment of the cephalostat or improper patient positioning in the cephalostat
- Marked asymmetry between right and left paired structures
- Marked size differences between right and left paired structures

**Q:** What is your assessment of this issue for Theo?

**A:** First, exact superimposition of right and left paired structures is confounded to a small degree by radiographic enlargement. Enlargement has the greatest impact on bilateral structures farthest from the sagittal midline (e.g. mandibular condyles and gonial angles) [3]. For maxillary canines, which lie closer to the sagittal midline, enlargement of the right vs. left canine in a standard cephalometric radiograph is ~0.15 mm. So, we conclude that the amount of anteroposterior difference in maxillary canines seen in Theo's cephalometric radiograph (~3 mm) has little contribution from enlargement.

Patient positioning can have dramatic effect on the superimposition of bilateral structures. Rotation of the cephalostat (or rotation of the patient by improper positioning in the cephalostat) by ~10° results in ~5 mm of anteroposterior image separation of the right and left maxillary canines and a larger (~8 mm) separation of the maxillary second molars (due to their greater distance from the mid-sagittal plane).

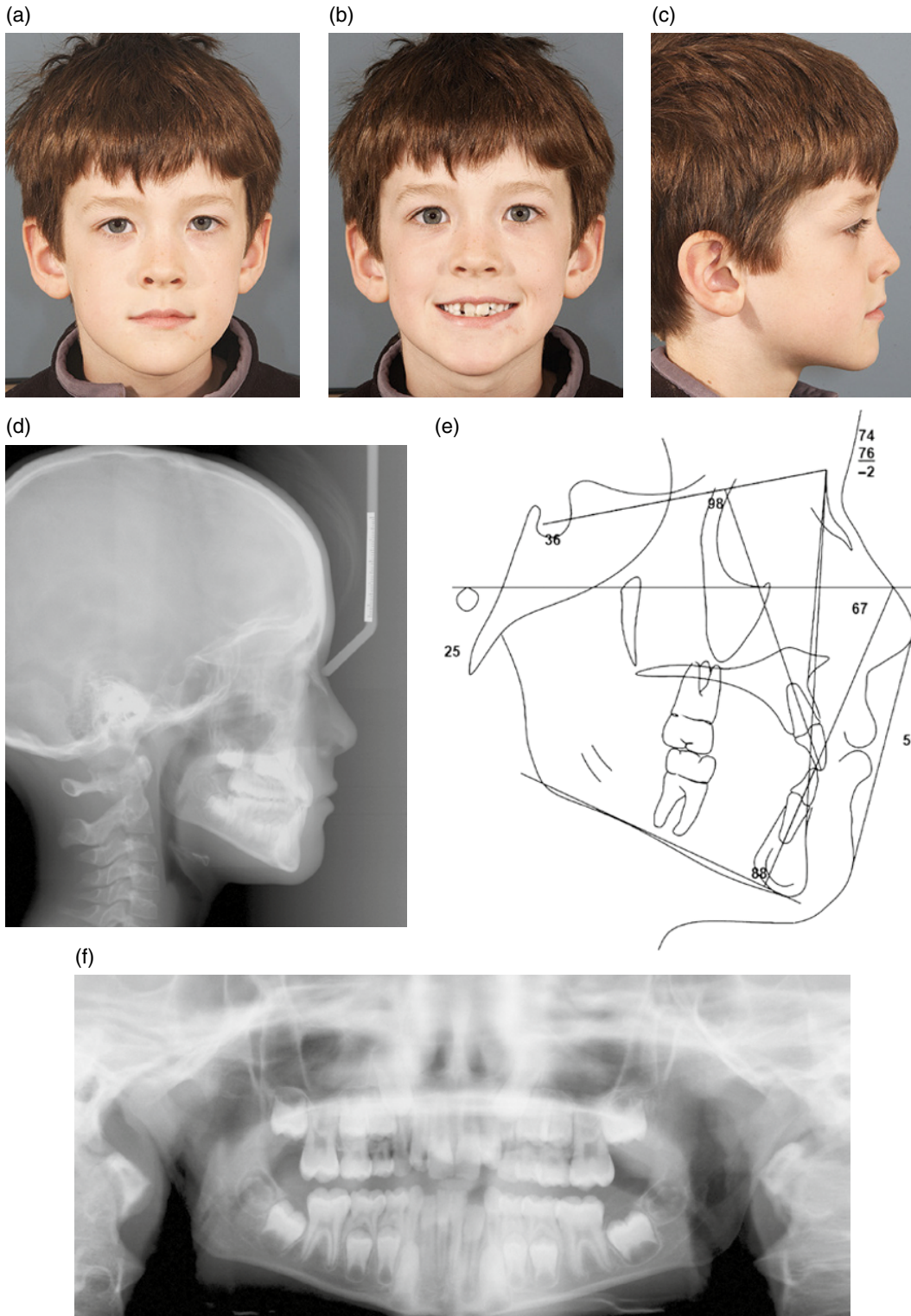
Looking at Theo's cephalometric radiograph, the ear-rods appear well aligned and the maxillary second molars show minimal (~2 mm) anteroposterior asymmetry. This suggests the anteroposterior image separation of Theo's maxillary canines does not have a significant contribution from patient rotation and may be due to spatial position asymmetry or size asymmetry of the maxillary canines.

Theo's panoramic radiograph suggests a vertical height difference in the right and left maxillary canines, supporting the similar finding on the cephalometric radiograph. Finally, bilateral tooth size asymmetry is not apparent.

Taking the cephalometric and panoramic information together, it may indicate a true difference exists in the anteroposterior and vertical positions of the right and left maxillary permanent canines.

**Q:** Why is this important?

**A:** In orthodontic diagnosis, asymmetry in spatial position of bilateral paired structures is a common finding. However, for developing maxillary canines, asymmetry in spatial position may be a clue to impending palatal or facial ectopic eruption and should be investigated further. This evaluation can include manual palpation of the maxillary alveolus from the facial in the area of the developing maxillary canine crowns to detect a difference in right and left prominence in the labial cortical plate, by periapical radiographic assessment using Clark's rule [4] or by 3-D radiography. None of these additional evaluations were performed on Theo.



**Figure 1.1** Initial records of Theo: (a–c) facial photographs, (d–e) lateral cephalometric radiograph and tracing, (f) pantomograph, (g–k) intraoral photographs.

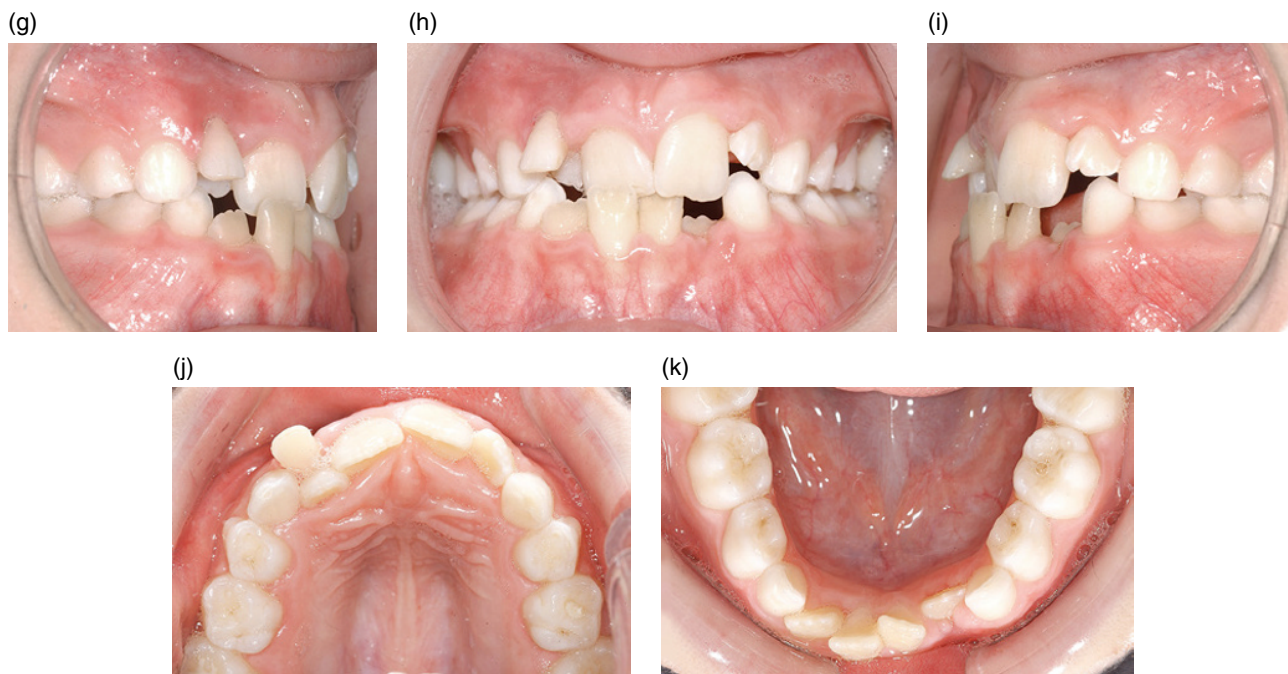


Figure 1.1 (Continued)



Figure 1.2 Enlargement of a portion of Theo's lateral cephalometric radiograph.

**Q:** What is meant by the term *apical base*? Are the terms *apical base discrepancy* and *skeletal discrepancy* interchangeable?

**A:** The term *apical base* refers to the junction of the alveolar and basal bones of the maxilla and mandible in the region of the apices of the teeth [5]. We will use the terms *apical base discrepancy* and *skeletal discrepancy* interchangeably.

**Q:** List your diagnostic findings and problems for Theo and make your diagnosis.

**A:**

Table 1.1 Diagnostic findings and problems list for Theo (*apical base/skeletal discrepancies italicized*).

Full face and profile	Frontal view
	Slight chin deviation to right
	Vertical facial proportions WRN (soft tissue Glabella-Subnasale approximately equal to Subnasale – soft-tissue Menton)
	Lip competence
	UDML WRN
	Mildly inadequate gingival display in posed smile (central incisor gingival margins apical to vermillion border of maxillary lip)

(Continued)

Table 1.1 (Continued)

	<p><b>Profile view</b></p> <p>Straight to mildly concave profile</p> <p>Obtuse nasolabial angle (NLA) with upturned nose</p> <p>Chin projection WRN</p> <p>Chin-throat length WRN</p> <p>Acute lip-chin-throat angle</p>
<b>Ceph analysis</b>	<p><b>Skeletal</b></p> <p>Maxillary anteroposterior skeletal position is <i>retrusive/deficient</i> (A-Point lies behind Nasion-perpendicular line, ANB = <math>-2^\circ</math>)</p> <p>Mandible also appears to be skeletally <i>retrusive/deficient</i></p> <p>Skeletal LAFH WRN (LAFH/TAFH <math>\times 100\%</math> = 56%; normal = 55%, sd = 2%)</p> <p>Mandibular plane angle WRN (FMA = <math>25^\circ</math>; SNMP = <math>36^\circ</math>)</p> <p>Effective bony Pogonion (Pogonion lies on extended Nasion-B Point line)</p>
<b>Radiographs</b>	<p><b>Dental</b></p> <p>Upright maxillary incisors (U1 to SN = <math>98^\circ</math>)</p> <p>Mandibular incisor inclination WRN (FMIA = <math>67^\circ</math>)</p> <p>Early mixed dentition stage of development</p> <p>Slight overlap of maxillary left permanent canine crown over maxillary left permanent lateral incisor root (possible ectopic eruption)</p>
<b>Intraoral photos and models</b>	<p>Angle Class III subdivision left</p> <p>Iowa Classification: I I III (1–2 mm) III (1–2 mm)</p> <p>OB 20%</p> <p>Maxillary permanent right central and right lateral incisors in lingual crossbite</p> <p>5 mm maxillary permanent incisor crowding (moderate crowding, Figure 1.1j)</p> <p>6 mm mandibular permanent incisor crowding (moderate crowding, Figure 1.1k)</p> <p>LDML to right of UDML by 2 mm</p> <p>Maxillary and mandibular arches are symmetric (Figures 1.1j – 1.1k)</p> <p>Thin labial periodontal biotype of mandibular right central incisor (Figure 1.1h)</p> <p>Traumatized maxillary central incisors edges (Figure 1.1h)</p> <p>Retained maxillary right primary lateral incisor</p>
<b>Other</b>	None
<b>Diagnosis</b>	Angle Class III subdivision left with anterior crossbite and moderate anterior crowding

**Q:** We judged Theo’s mandibular skeletal anteroposterior position to be deficient, in spite of the fact that his ANB angle is  $-2^\circ$  (an ANB value usually associated with mandibular anteroposterior excess). Why did we judge his mandibular skeletal anteroposterior position to be deficient?

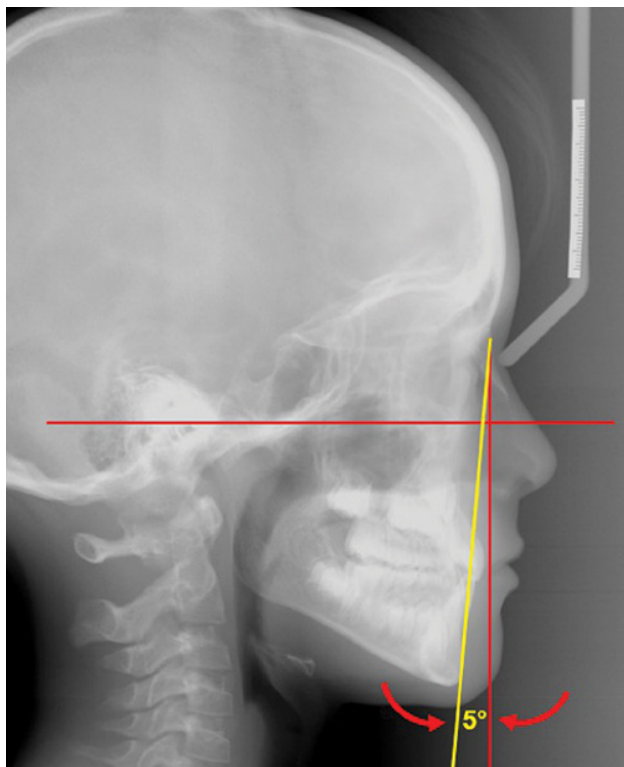
**A:** If Theo’s maxilla was in a normal anteroposterior position, then A-Point would lie on the Nasion-perpendicular line, and we could use ANB angle to judge his mandibular anteroposterior position. However, as discussed in the Appendix, because his maxillary position is *deficient* (A-Point lies behind Nasion-perpendicular line), we cannot use his ANB angle to judge his mandibular anteroposterior position.

Instead, we use the angle formed between the Nasion-perpendicular line itself and the Nasion B-Point line to judge his mandibular skeletal anteroposterior position.

If we measure this angle (Figure 1.3), we find that it equals  $5^\circ$ , indicating that his mandible is skeletally deficient. In other words, Theo has a skeletally deficient maxilla *and* mandible.

**Q:** But Theo has a straight, even a mildly concave, profile. He does not have a convex profile, which generally indicates a deficient mandible. Furthermore, he has a left side Class III dental relationship – not a Class II dental relationship indicative of a deficient mandible. How do you explain this?

**A:** The explanation is found in his deficient maxilla. Although Theo’s mandible is deficient relative to Nasion-perpendicular line, his mandible is excessive *relative* to his deficient maxilla (ANB angle =  $-2^\circ$ ). It is not unusual for patients with normal mandibles to appear mandibular excessive when they have a



**Figure 1.3** Measurement of the angle formed between the Nasion-perpendicular line (red vertical line) and the Nasion B-Point line (yellow line). This angle was found to be 5° indicating that the mandibular skeletal anteroposterior position is deficient. Therefore, both Theo's maxilla and mandible are deficient anteroposteriorly.

deficient maxilla. We must remain cognizant of this inconsistency as we treatment plan Theo and as we monitor his future growth.

- Q:** Theo is eight years old with an upturned nasal tip, adequate chin projection, and adequate chin-throat length. What changes do you anticipate in his nasal tip, chin projection, and chin-throat length as he grows and develops?
- A:** We anticipate that Theo's nasal tip angle will *decrease* with age [6] and both his chin projection and chin-throat length will *increase* with age [7].
- Q:** We noted that Theo exhibits a thin labial periodontal biotype covering his mandibular right central incisor. What does this mean? What is our concern with having a thin labial biotype during orthodontic treatment? How would you deal with this finding?
- A:** A thin labial biotype is characterized by a narrower zone of attached keratinized tissue than normal and a thinner facial-lingual gingival dimension than normal. A thick biotype is characterized by a wider zone of

attached keratinized tissue and a thicker facial-lingual gingival dimension [8–12]. If mandibular incisor roots are covered by periodontium exhibiting a thin biotype, then gingival recession may occur if the incisor roots are moved labially or rotated (stressing the tissue). On the other hand, less than 1 mm of attached gingiva may be compatible with gingival health [13–17].

Based upon these points, and because Theo has *some* keratinized attached gingival tissue labial to his mandibular central incisor, we recommend monitoring Theo's mandibular anterior gingival tissues for now. However, his parents should be informed that the need for a future gingival graft exists if recession occurs at this site.

- Q:** Look at the photographs (Figures 1.1h – 1.1i). What do you note regarding the angulation of the maxillary left permanent lateral incisor? Why could this be important?
- A:** The maxillary left permanent lateral incisor appears to have its crown inclined to the labial and the root inclined to the lingual. Given the partial overlap of the maxillary left permanent canine crown and maxillary left permanent lateral incisor root (Figure 1.1f), this suggests the crown of the developing maxillary left permanent canine could be positioned to the labial of the lateral incisor root. Orthodontic movement of the lateral incisor root to the labial may cause root resorption.
- Q:** We stated that Theo's Angle Classification was Class III subdivision left and that his Iowa Classification was: I I III (1–2 mm) III (1–2 mm). What do we mean by Iowa Classification?
- A:** For years, we were frustrated using the Angle Classification system because it fails to quantify – that is to provide the orthodontist with a sense of discrepancy *magnitude*. In other words, when a patient is said to be Angle Class II does that mean that the patient is slightly Class II or severely Class II? The orthodontist is left without any sense of whether the patient needs Class II elastic wear or orthognathic surgery. Furthermore, we feel that canine anteroposterior relationships are just as important as molar relationships. The Angle Classification system lacks this detail.
- We decided to modify the Angle system by quantifying the anteroposterior discrepancy at the patient's right molar, right canine, left canine, and left molar. (Please see the Appendix). For Theo that results in an Iowa Classification of: I I III (1–2 mm) III (1–2 mm).
- Q:** What are Theo's *primary*, or major, problems in each dimension, plus other problems that you need to remain focused on?

**A:****Table 1.2** Primary problems list for Theo (*apical base/skeletal discrepancies italicized*).

<b>AP</b>	Angle Class III subdivision left Iowa Classification: I I III (1–2 mm) III (1–2 mm) <i>Maxillary and mandibular skeletal anteroposterior deficiency</i>
<b>Vertical</b>	-
<b>Transverse</b>	-
<b>Other</b>	Anterior crossbite Possible ectopic eruption of maxillary left permanent canine Moderate anterior crowding in both arches

**Q:** Discuss Theo in the context of three principles applied to every early treatment patient.

- 1) The goal of early treatment is to correct developing problems – get the patient *back to normal for their stage of development* (including preventing complications such as resorption of adjacent tooth roots, reducing later treatment complexity, or reducing/eliminating unknowns). Theo’s anterior crossbite, left Class III relationship, maxillary left permanent canine possible ectopic eruption, and moderate anterior crowding would need to be corrected to get him back to normal.
- 2) Early treatment should be applied to correct *very specific problems with a clearly defined endpoint*, usually within six to nine months (except for anteroposterior skeletal and skeletal open-bite orthopedics). Correction of Theo’s anterior crossbite has a clearly defined endpoint and could be accomplished with fixed orthodontics in a few months. His moderate anterior crowding has a clearly defined endpoint, but improvement/correction could take longer than six to nine months (using space maintenance/fixed appliances) depending upon how long it takes his permanent canines and premolars to erupt. Correction of his possible ectopically erupting maxillary left permanent canine could take longer than nine months. Finally, correction of Theo’s left Class III relationship could take years of orthopedic treatment, depending upon his future growth and compliance.
- 3) Always ask: Is it necessary that I treat the patient now? *What harm will come if I choose to do nothing?* It is important to treat Theo’s anterior crossbite now to prevent additional incisor trauma/wear.

Without early treatment anterior crowding will remain, and unerupted permanent canines could

become impacted or erupt blocked out. The risk of maxillary left permanent canine impaction is of special concern to us (note overlap of the maxillary left permanent canine crown across the maxillary left lateral incisor root, Figure 1.1f). Further, the maxillary left permanent canine crown could resorb the maxillary left permanent lateral incisor root.

Without Class III orthopedic treatment, maxillary deficient forward growth (relative to mandibular forward growth) could worsen Theo’s left Class III relationship. Worsening of Theo’s left Class III relationship could also result from mandibular permanent first molar mesial drift if an LLHA is not placed before exfoliation of his mandibular primary canines and molars.

**Q:** We noted that Theo’s chin is deviated slightly to the right, CR = CO, his LDML is to the right of his UDML and face, and he is Class III on the left by 1–2 mm. What do these findings suggest?

**A:** These findings suggest that his mandible may be growing asymmetrically, with slight excess left mandibular forward growth.

**Q:** What unknowns do you face with Theo’s care?

**A:** His future jaw growth (magnitude and direction), treatment compliance, and a potential undetected CR-CO shift are significant unknowns.

**Q:** What early treatment option(s) would you consider for Theo?

**A:** Early treatment options could include:

- *Recall (monitor only) and re-evaluate in one year – is not a recommended option.* Why? Risks include additional incisor trauma, increasing ectopic eruption of Theo’s maxillary left permanent canine (increasing the risk of canine impaction and/or lateral incisor root resorption [16]), and continued Class III skeletal growth.
- *Anterior crossbite correction – is recommended* and could be performed in a number of ways. After extracting his maxillary right primary lateral incisor, you could: (i) ask Theo to close gently on a tongue blade covered with gauze (or on a soft suction tip) throughout the day in order to advance his right maxillary incisors; (ii) ask Theo to wear a removable maxillary biteplate with finger springs to advance his maxillary incisors; or (iii) place fixed orthodontic appliances to advance his maxillary right incisors. Also, some anterior crossbites will self-correct from tongue pressure alone if the patient’s bite is

first opened with bilateral band cement bonded on the permanent first molar occlusal surfaces.

Note: advancing the maxillary right lateral incisor crown forward will tend to drive its root reciprocally into the erupting canine crown – potentially resorbing the lateral incisor root. This must be explained to the parents. If you advance the lateral incisor crown, do so gently and slowly.

- *Extracting his maxillary primary canines and maxillary primary first molars – is a viable option when his maxillary first premolar roots are at least half developed.* Why? Eruption of the maxillary first premolars would be accelerated, which would make room for the maxillary permanent canines to erupt, thereby lessening the chance that his maxillary left permanent canine will be impacted [18, 19]. Generally, *a primary tooth should not be removed until its permanent successor has at least half of its root length formed* [20, 21]. Earlier primary tooth extraction can cause delayed eruption and emergence of its successor, probably as a result of scar tissue forming a mechanical barrier [22].
- *Space maintenance – is recommended, but not yet.* Placement of an LLHA could (i) prevent/minimize worsening of Theo's left Class III relationship due to permanent first molar mesial drift as his mandibular primary teeth exfoliate; and (ii) reduce mandibular anterior crowding as primary teeth exfoliate (leeway space). However, since the roots of his mandibular permanent canines and premolars are less than half formed (Figure 1.1f), their eruption is not imminent and placement of an LLHA would be premature [23].
- *Extraction of mandibular primary canines – to permit spontaneous mandibular incisor alignment.* We do not recommend this option since mandibular incisor crowding is not a concern for Theo or his parents. If you decided to extract mandibular primary canines, then we would strongly recommend placement of an LLHA to maintain arch perimeter and reduce mesial molar drift (worsening of the left Class III relationship).
- *Orthopedic treatment (e.g. reverse pull face mask therapy) – is a possible option to improve/correct Theo's left Class III molar relationship by advancing his maxilla/maxillary teeth.* Note: orthopedic treatment *will not normalize* Theo's growth. If Theo's maxilla is advanced orthopedically, then its position will need to be overcorrected in anticipation of future deficient maxillary growth, or he will need to be placed in a high-pull chin cup (or temporary anchorage device (TAD)-supported Class III elastics) to maintain the

correction – until he is finished growing. If excess left asymmetric mandible forward growth is identified, then asymmetric orthopedics (TAD supported Class III elastics) may be required on his left.

- *Extraction of his retained maxillary right primary lateral incisor – is recommended if it does not exfoliate spontaneously.*

**Q:** Based upon the above discussion, do you recommend recalling Theo in nine to twelve months (no treatment, monitoring only), or, do you recommend early treatment? If you recommend early treatment, what treatment would you perform?

**A:** We extracted Theo's maxillary right primary lateral incisor. Our early treatment objective was to correct his maxillary right central incisor crossbite by advancing it with fixed appliances and compressed open coil springs placed between his central incisors and primary canines (Figure 1.4). Band cement was bonded to the occlusal surfaces of his maxillary first permanent molars as a bite plate to open his bite and allow his maxillary right central incisor to advance, unimpeded.

We did not bracket the maxillary lateral incisors because they were not in traumatic occlusion and because we were concerned about possibly driving their roots reciprocally into the erupting permanent canine crowns (potential root resorption). Surprisingly, the maxillary right permanent lateral incisor *spontaneously* shifted forward out of lingual crossbite following extraction of the maxillary right primary lateral incisor



**Figure 1.4** Maxillary fixed appliances were placed to advance Theo's maxillary right central incisor out of crossbite. We did not advance his maxillary right permanent lateral incisor for fear that moving its crown forward would drive its root reciprocally into the erupting permanent canine crown (potentially causing lateral incisor root resorption). Surprisingly, the maxillary right lateral incisor *spontaneously* shifted forward out of lingual crossbite following extraction of the maxillary right primary lateral incisor. We speculate that this movement resulted from either tongue pressure or transeptal fiber pull.

and advancement of the maxillary right permanent central incisor (Figure 1.4).

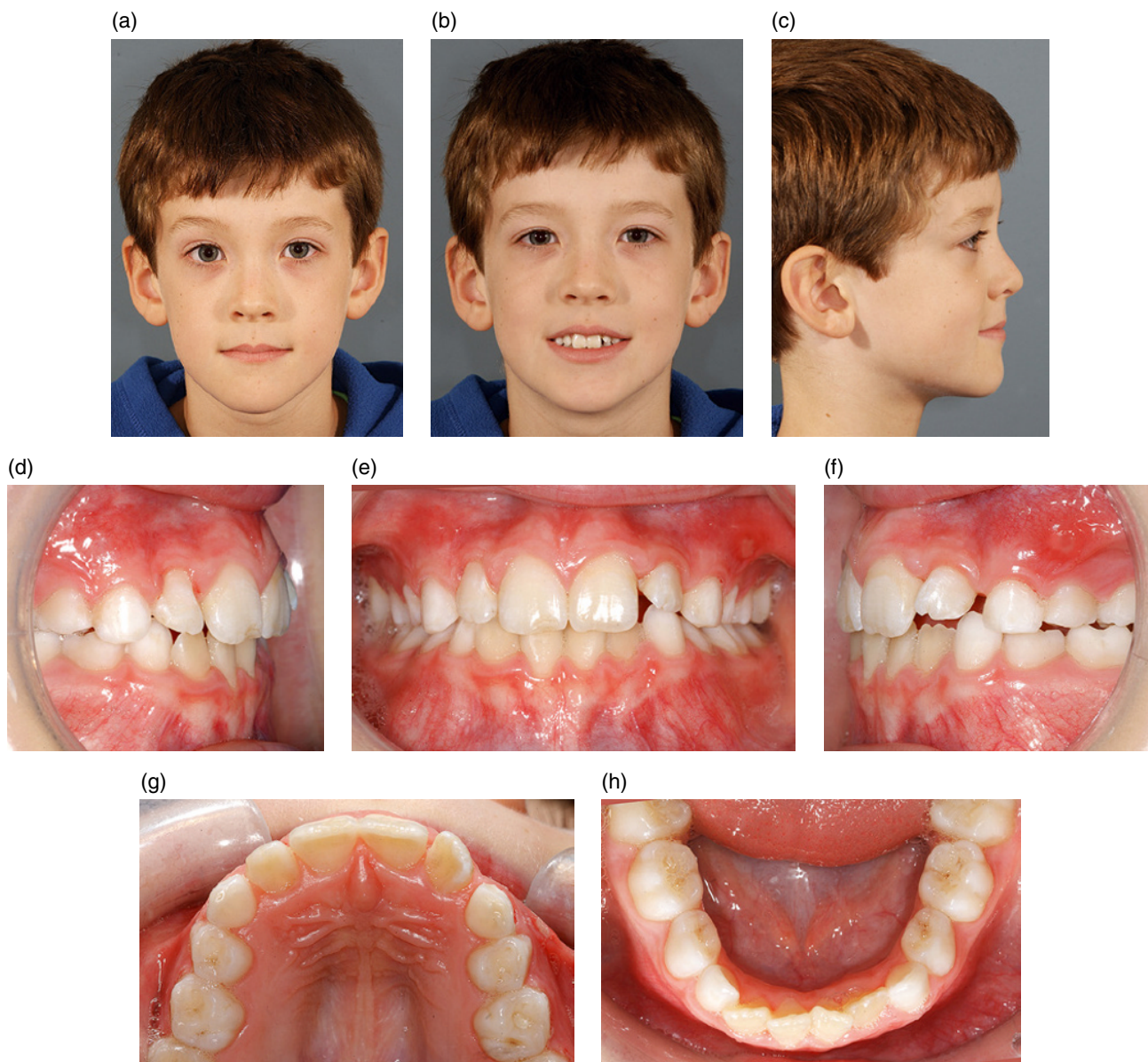
We decided to delay placement of an LLHA until Theo's mandibular permanent canines and premolars were closer to eruption. Also, we decided to postpone Class III orthopedic treatment. Why? Although Theo's anteroposterior relationship would be monitored, orthopedic treatment was deemed aggressive at this time considering his mild unilateral Class III magnitude (1–2 mm).

Finally, we decided not to extract Theo's maxillary primary canines and maxillary primary first molars. Why? The maxillary left permanent canine crown

overlap of the maxillary left lateral incisor root was minimal (Figure 1.1f), and his first premolar roots were less than half developed.

**Q:** Look at Theo's early treatment deband photographs (Figure 1.5). Was our early treatment successful? Did we achieve our goals?

**A:** Yes and no. We achieved our goal to correct Theo's anterior crossbite. However, he is still Class III on his left side, he still has mandibular anterior crowding, and his maxillary left permanent canine is still erupting ectopically. These are problems that we must continue to monitor and eventually address to get him back on track.



**Figure 1.5** (a–h) Early treatment deband photographs of Theo. Previous incisal wear, especially of the maxillary right central incisor, is clearly evident.



**Q:** How do you recommend proceeding?

**A:** We made Theo an appointment to return in one year. At that time, we planned to make another panoramic radiograph. If Theo's maxillary left permanent canine crown was seen to overlap his maxillary permanent lateral incisor root more than on the initial panoramic radiograph, then we would extract his maxillary primary canines and primary first molars (assuming the premolar roots were at least half developed). These extractions would accelerate eruption of the first premolars and thus create an eruption path for the permanent canines.

We planned to place an LLHA when Theo approached exfoliation of his mandibular primary canines and primary molars. Finally, we planned to monitor his left Class III relationship, instituting orthopedic treatment (RPHG, high-pull chin cup, or TAD-supported Class III elastics), if his left Class III relationship worsened.

**Q:** Despite repeated attempts to schedule Theo to return to our clinic, he failed to do so until he was fifteen years old (Figure 1.6). List changes that have occurred since we last saw him (Figure 1.5).

**A:** Changes include:

- Most permanent teeth have erupted, but the maxillary right primary canine and mandibular left primary canine are retained.
- Theo had significant Class III dental compensation changes. His maxillary incisors proclined (U1 to SN angle increased from 98° to 108°, compare (Figures 1.1e and 1.6e) while his mandibular incisors uprighted (FMIA increased from 67° to 77°).
- Worsening of his *right* occlusal relationship to Class III (1 mm), and slight improvement on his left side from Class III (1–2 mm) to nearly Class I. Why? One possible explanation is that Theo grew Class III skeletally but had more available space in his upper left quadrant from lateral incisor to molar (Figure 1.5g) than in his upper right quadrant, which allowed him to obtain dental Class I on the left during permanent tooth eruption and mesial drift.
- Maxillary left permanent canine, the canine that initially concerned us, erupted normally. However, the maxillary *right* permanent canine became palatally impacted (Figure 1.6f). Note the slight palatal soft-tissue bulge covering the impacted maxillary right permanent canine (Figure 1.6j).
- Both mandibular canines erupted into 90° rotated positions (Figure 1.6k). The mandibular left canine erupted lingually.
- A moderate amount of mandibular anterior crowding exists (~6 mm of total mandibular permanent canine crowding)

- The mandibular anterior labial periodontal biotype appears to have thickened (Figure 1.6h)
- We noted that Theo's maxillary lateral incisors were small mesiodistally. His parents were informed that he would possibly need composite veneers to give them a more ideal mesiodistal width.

**Q:** Could we have prevented palatal impaction of the maxillary right permanent canine?

**A:** Possibly. If further investigation of the noted asymmetry of the maxillary permanent canines had been done, our findings may have prompted us to be more aggressive toward improving the potential for its normal eruption. Theo's lack of appointment compliance also limited our ability to monitor and evaluate its development.

This raises an important point. Early treatment always involves a *monitor and evaluate* component, be it when you decide no early treatment is needed and place your patient on recall, or when you have completed a focused early treatment and continue to monitor the patient. You must always stress to the parents of early treatment patients that *periodic observation is important to minimize developing problems*. We may have been able to lessen Theo's developing maxillary canine problem if periodic observation had been maintained.

**Q:** We noted that Theo's mandibular anterior labial periodontium appears to have thickened. What does the literature say about maxillary and mandibular anterior labial keratinized gingival widths in children six to twelve years of age?

**A:** In well-aligned teeth, *increases in width* of the facial keratinized and attached gingiva can take place [13].

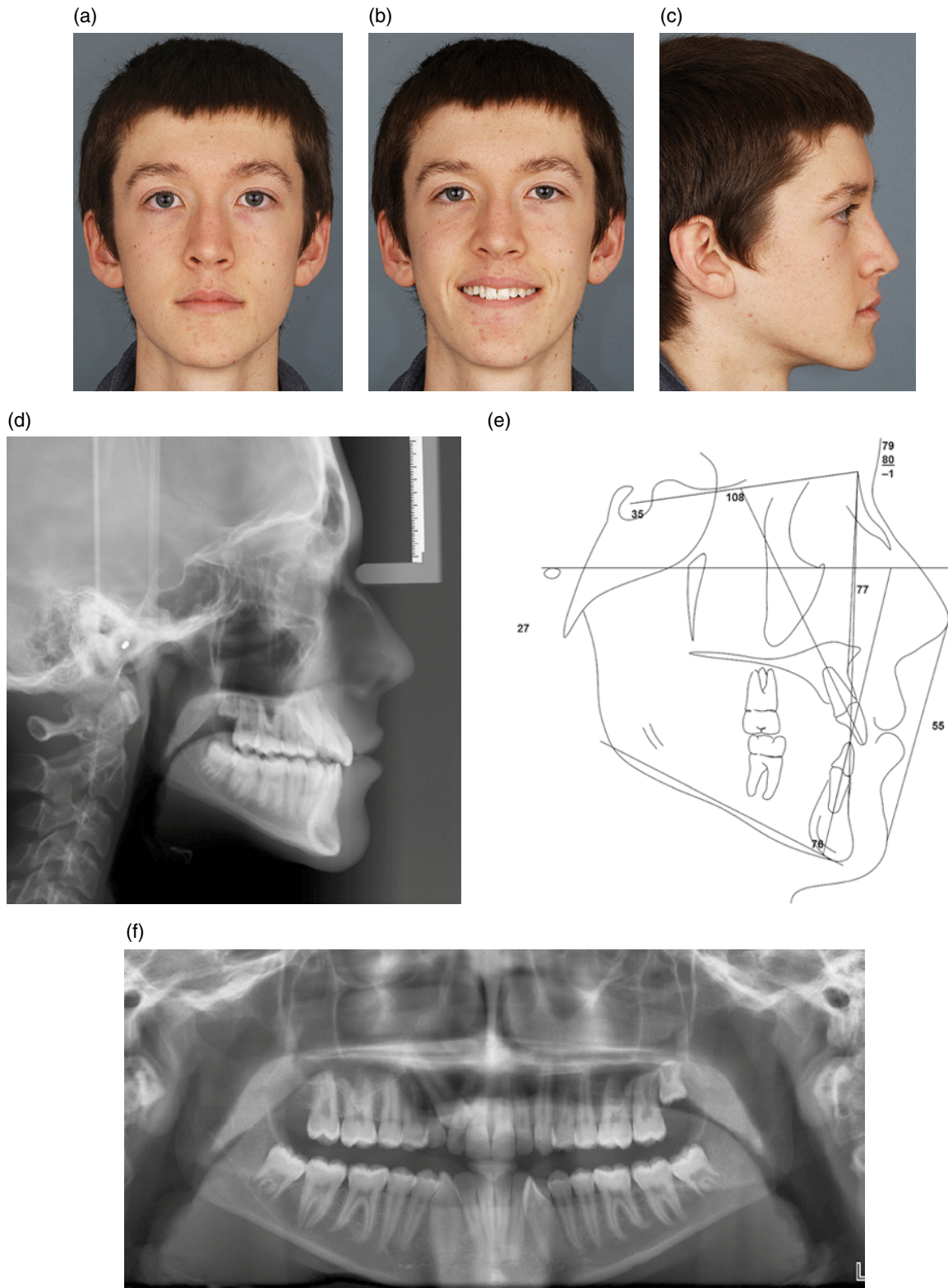
**Q:** Was Theo's early treatment warranted?

**A:** Yes. Correction of Theo's anterior incisor crossbite was effective and necessary.

**Q:** What else should have been done during the years that Theo failed to return to clinic?

- A:** An LLHA should have been placed before exfoliation of Theo's primary canines and primary molars in order to:
- Prevent mesial drift of mandibular molars. If mandibular molar mesial drift had been prevented, then Theo could now be in a bilateral Class I molar relationship instead of Class III on his right.
  - Provide leeway space for improved mandibular anterior teeth alignment (especially mandibular canine alignment)

In addition, periodic panoramic radiographs should have been made in order to evaluate the eruption path



**Figure 1.6** Records of Theo when he returned to our clinic at age fifteen years: (a–c) facial photographs, (d–e) lateral cephalograph and tracing (note that his dental arches were slightly separated when the cephalometric radiograph was made), (f) pantomograph, (g–k) intraoral photographs.

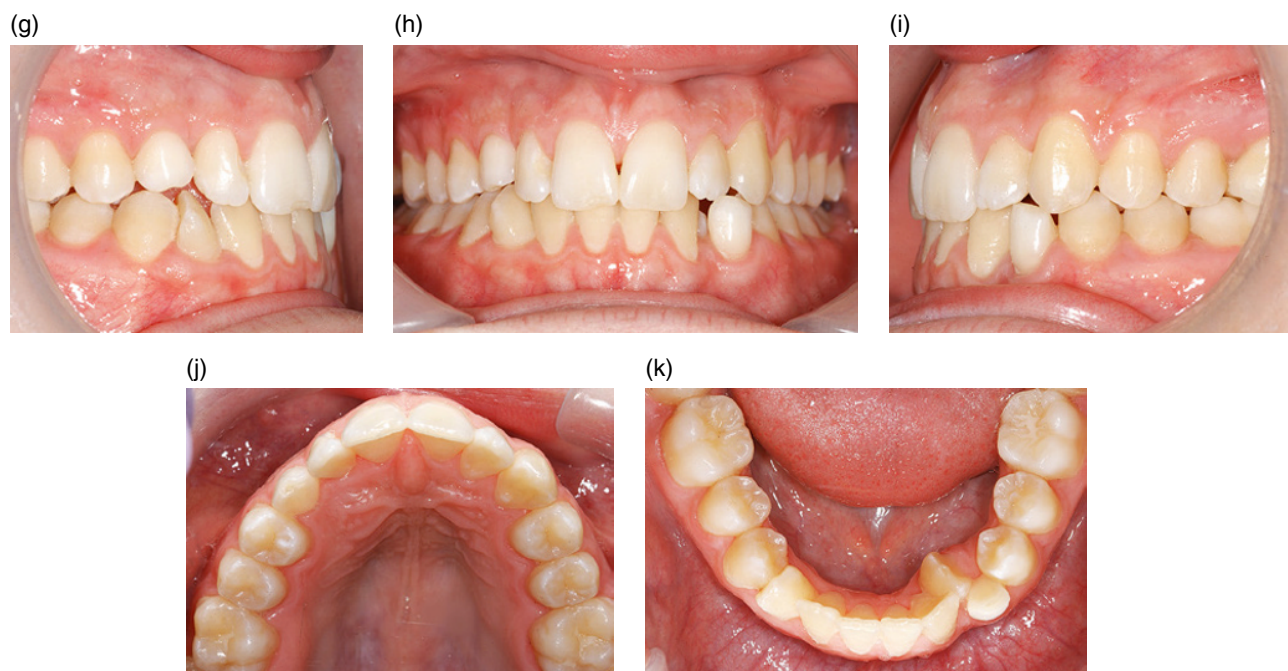


Figure 1.6 (Continued)

of the permanent maxillary canines. We would have likely seen the earlier ectopic path of the maxillary left permanent canine improving with growth. The eventual ectopic path of the maxillary right permanent canine would have been seen earlier in Theo's development, allowing steps to be taken to improve the path of eruption prior to the full development of his adolescent dentition.

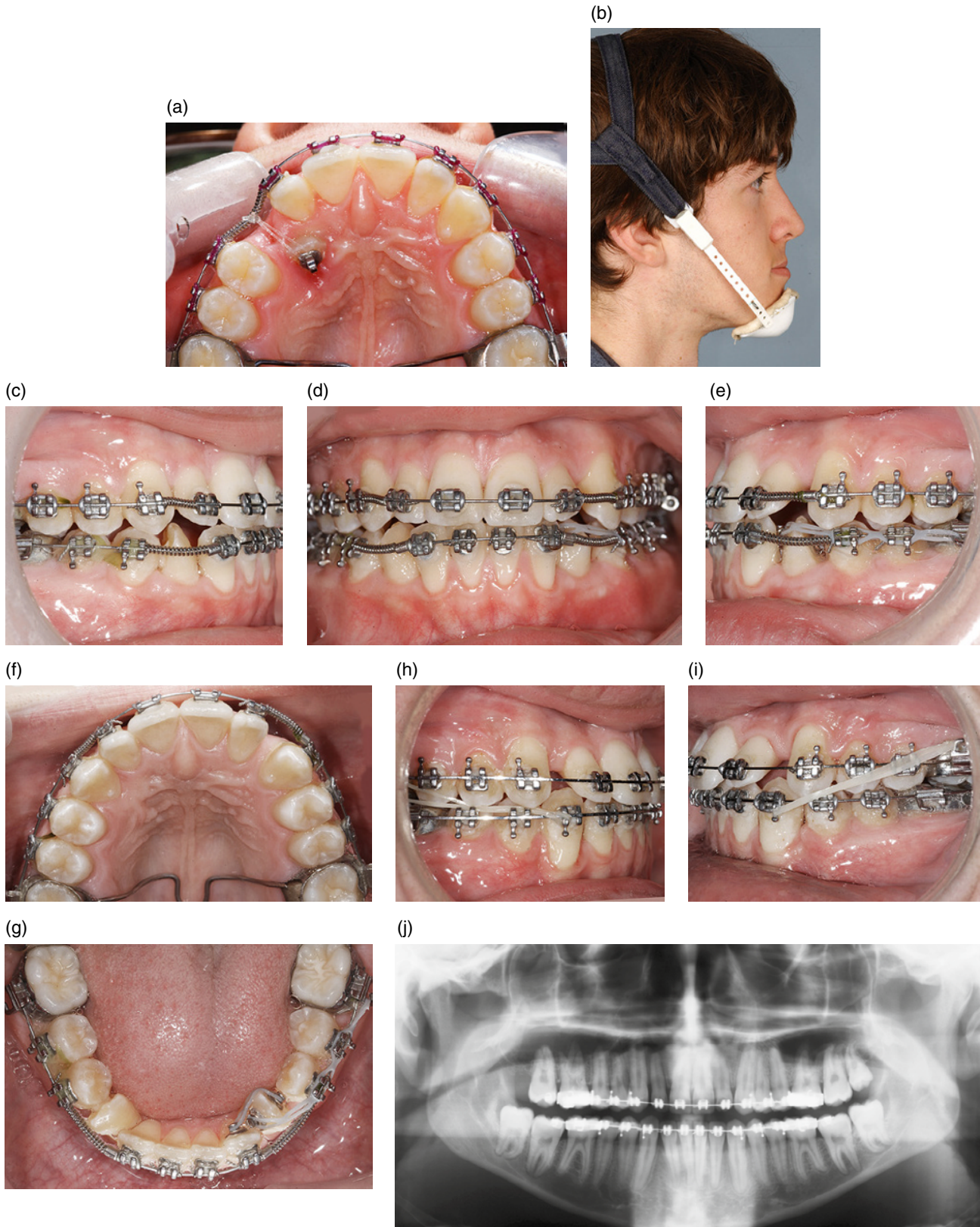
Also, Theo's growth should have been monitored, annually. We were lucky that Theo did not grow more Class III than he did. *Periodic observation is important to minimize the difficulty of developing problems.*

- Q:** Except for two retained primary teeth, Theo is now in the permanent dentition and ready for comprehensive orthodontic treatment. Although comprehensive treatment is not the focus of this book, do you have any recommendations on how to proceed?
- A:** Theo's mandibular incisors are upright, their labial periodontium has thickened, and he exhibits approximately 6 mm of mandibular anterior crowding. For these reasons, we decided to attempt comprehensive *nonextraction* treatment by aligning the mandibular anterior teeth. As they are aligned, the incisors will procline and tend to move into anterior crossbite. To avoid this, overjet would need to be created by proclining the maxillary incisors (spaces would be opened for composite veneers on the distal of the small maxillary lateral incisors). A reasonable alternative treatment

would be to extract a mandibular incisor to gain space for alignment. This treatment would result in less maxillary incisor proclination but more upright mandibular incisors.

Treatment began. To address the impacted maxillary right permanent canine, a transpalatal arch was placed, and a distal elastic traction force applied to the impacted maxillary right canine after it was surgically exposed. This force pulled the maxillary right canine crown *away* from the maxillary right lateral incisor root before the canine was moved laterally into arch alignment. We did this in order to avoid resorption of the lateral incisor root by the canine crown. The two retained primary canines were extracted. Maxillary fixed orthodontic appliances were placed. Using elastics, the maxillary right permanent canine was moved laterally into alignment within the arch (Figure 1.7a).

Anterior overjet was next created by making spaces between the maxillary lateral incisors and maxillary canines using open coil springs. This overjet would allow alignment (proclination) of mandibular anterior teeth without creating an anterior crossbite. A few months later, we noticed that Theo had grown more Class III (2 mm). He was placed on a high-pull chin cup (Figure 1.7b, 250 grams per side) to reduce and redirect mandibular forward growth while hoping maxillary forward growth would continue. He wore it from eight pm each night until morning.



**Figure 1.7** (a–u) Progress records of Theo. The panoramic radiograph in J was made one month prior to deband, and we did not make a panoramic image after deband because of radiation hygiene. (k–u) Deband records of Theo. The cephalometric superimposition (p) illustrates the bony and dental changes which occurred during comprehensive treatment.

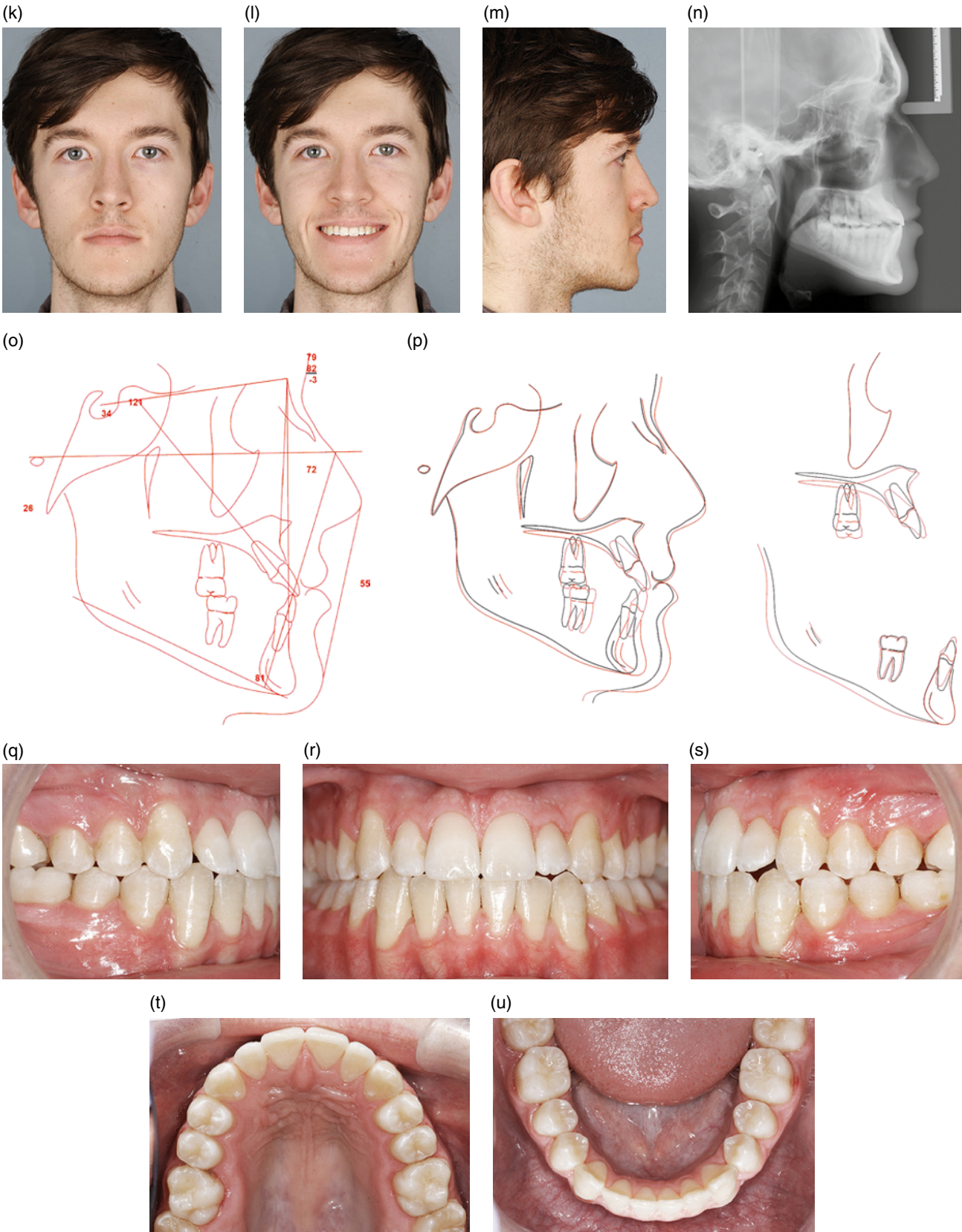


Figure 1.7 (Continued)

Theo was very compliant with chin cup wear. Mandibular-fixed orthodontic appliances were placed, and both arches were leveled and aligned (Figure 1.7c–g). Note in Figure 1.7g that space is being created for the mandibular right canine using a compressed open coil spring inserted between the lateral incisor and first premolar, and the mandibular left canine is being rotated with a couple (equal but opposite elastic forces on the buccal and lingual canine surfaces). Because of his excellent chin cup wear, Theo's Class III molar and canine relationships did not worsen, and we felt comfortable using Class III elastics to correct his 2 mm Class III relationship (Figures 1.7h–1.7i).

We began closing maxillary anterior spaces until anterior overjet was eliminated. The black triangle between his maxillary central incisors (Figure 1.7d) was eliminated by enameloplasty of the mesio-incisal corners of the central incisors followed by space closure. Because Theo's maxillary lateral incisors were small, we anticipated him needing maxillary lateral incisor composite veneers at the end of treatment to fill in residual spaces and give his maxillary lateral incisors the correct mesiodistal widths. However, we found that when a Class I canine relationship was achieved, we were able to close all maxillary spaces. This probably occurred because his mandibular incisors were upright (mandibular incisal edges were further back requiring less overjet than if they were proclined).

Theo's height was monitored throughout comprehensive treatment. By age seventeen he had stopped growing. Comprehensive orthodontic treatment, including finishing, was completed by age eighteen (deband records are shown in Figures 1.7k–1.7u). He was placed in maxillary and mandibular Hawley retainers.

We were pleased with Theo's final facial esthetics, smile, function, and occlusion. As expected, Theo had significant facial growth during comprehensive treatment (cephalometric superimpositions, Figure 1.7p). His maxilla underwent anterior rotation as a result of growth and treatment moving downward posteriorly and showing very little forward growth overall. His mandible grew downward and forward with mild anterior rotation.

We were not pleased with the uprightness of his mandibular incisors nor with the proclination of his maxillary incisors (Figures 1.7n and 1.7o), which reflect dental compensations for his differential maxillo-mandibular growth (mandible grew forward significantly, maxilla grew forward considerably less). We were not pleased with the second-order angulation of his maxillary left second premolar and his mandibular right lateral incisor (Figure 1.7j). His maxillary left

lateral incisor also displays too much mesial and lingual root angulation, contributing to the appearance of a shorter clinical crown. This was the clinical position of this tooth at the start of early treatment, and we neglected to focus on this problem during comprehensive treatment.

Finishing imperfections notwithstanding, Theo and his parents were ready to have his braces removed. We recommended that Theo have his maxillary left lateral incisor lengthened slightly with a composite veneer, but Theo declined.

In summary, Theo's *early* treatment consisted of anterior crossbite correction, which was completed by nine years of age and which prevented further incisor damage. However, we failed to place an LLHA at that time, we wish we had instituted Class III orthopedic treatment sooner than we did, but Theo disappeared for six years.

**Q:** Theo was included as an example in this section in order to underscore important concepts about early treatment diagnosis, treatment planning, and treatment delivery. Can you suggest other important concepts that his case illustrates?

**A:** These concepts are as follows:

- *Early treatment is only one piece of total orthodontic care.* Early treatment can be critically important. However, even if you get your patient back on track with early treatment, total treatment is incomplete until you have achieved excellent adult occlusion, function, tissue health, and facial esthetics. In addition, even after you successfully complete comprehensive treatment in the adult dentition, you must monitor the patient in retention. We did the right thing by treating Theo's anterior crossbite early, but we were committed to caring for him until his comprehensive treatment was complete as an adult – and beyond.
- Orthodontic treatment, including early orthodontic treatment, relies heavily on patient compliance. Theo failed to return to our clinic for years, during which time important early treatment opportunities (growth modification, space maintenance, and management of ectopically erupting teeth) were missed. *Periodic observation is important to minimize the difficulty of developing problems.*
- Cephalometric findings should corroborate clinical observations. When inconsistencies are noted between cephalometric findings and clinical observations, pay special attention. According to his cephalometric analysis, Theo presented with an anteroposterior mandibular deficiency (relative to Nasion-perpendicular line). Clinically, he appeared