Table of Contents

Preface ix
Contributors xii

SECTION I—HISTORY OF THE CONCEPT

Chapter 1 The Dental Contour Appliance: A Historical Review 3
Henry I. Nahoum

Chapter 2 Essix Technology: Tooth Movement and Retention 11
John Sheridan

Chapter 3 History and Overview of the Invisalign System 25
Trang Duong

SECTION II—MODELING IN THE INVISALIGN SYSTEM

Chapter 4 Polyvinyl Siloxane Impression Materials 35
John M. Powers

Chapter 5 Align's Standard on Quality Impressions 43
David Chenin

Chapter 6 Scanning Process and Stereolithography 47
Srinivas Kaza

Chapter 7 Invisalign Software 55
Andrew Beers

Chapter 8 Virtual Diagnostic Setup 67
David Chenin and Kent Verdis

Chapter 9 Attachments 77
Peter Knopp and Mitra G. Derakhshan

Chapter 10 Invisalign Attachments: Materials 91
Eric Kuo and Trang Duong
Chapter 11  ClinCheck: Overview and Preparation 99  
Craig Crawford

Chapter 12  Staging 105  
Rene Sterental

Chapter 13  Overcorrection: Principles and Considerations 115  
Eric Kuo

Chapter 14  Three-Dimensional Superimposition Tool 121  
C. Van Nguyen and Jihua Cheng

Chapter 15  Virtual Invisalign Practice 133  
David Chenin

Chapter 16  Computer-Oriented Dental Measurements 137  
Vadim Matov

SECTION III—PERFORMANCE CHARACTERISTICS OF THE INVISALIGN SYSTEM

Chapter 17  Mechanics of Tooth Movement with Invisalign 149  
Andrew Beers and Trang Duong

Chapter 18  Applications of Mechanics with Invisalign 153  
Heng Cao and Trang Duong

Chapter 19  Biologic Elements of Tooth Movement 163  
Orhan C. Tuncay

Chapter 20  Properties of Aligner Material Ex30 177  
Robert Tricca and Chunha Li

Chapter 21  Ex40 Material and Aligner Thickness 187  
Trang Duong, Eric Kuo, and Mitra G. Derakhshan

Chapter 22  Extraction Treatment with Invisalign 195  
David E. Paquette

Chapter 23  Force Application with Invisalign: Constancy and Compliance 207  
Trang Duong and Robert Tricca
SECTION IV—CLINICAL CONSIDERATIONS IN USING THE INVISALIGN SYSTEM

Chapter 24  Advantages of the Invisalign System  215
           Trang Duong and Mitra G. Derakhshan

Chapter 25  Review of the Diagnostic Process  223
           Robert L. Boyd

Chapter 26  Interproximal Enamel Reduction  255
           Rainer-Reginald Miethke and Paul-Georg Jost-Brinkmann

Chapter 27  Facial Esthetic Examination and Analysis  271
           Marc B. Ackerman

Chapter 28  Surgical Treatment and Invisalign  283
           Ross Miller and Trang Duong

Chapter 29  Feasibility Study of the Invisalign System in Treatment of Adolescents  293
           Andrew Trosien and Robert Fry

Chapter 30  Data Mining: Principles and Considerations  301
           Eric Kuo

SECTION V—OFFICE DESIGN AND TECHNOLOGY

Chapter 31  Invisalign Office Design and Technology  309
           Orhan C. Tuncay, Marc S. Lemchen, and Agnes A. Kan
Preface

The long-awaited paradigm shift in orthodontics arrived with the introduction of the Invisalign System. This unique treatment approach has been instrumental in removing the ever-present shroud of mystery surrounding orthodontics by allowing both dental practitioner and patient to develop a visual understanding of orthodontic tooth movement. In this way, it has founded a culture of true and attainable visual treatment objectives. Moreover, the esthetic and practical advantages of the system have extended orthodontic services to a greater population.

The Invisalign System is multilingual. Its spoken languages are image acquisition, software (ClinCheck), and the Invisalign aligner. The dialects are the generation of forces, attachment designs, and response of periodontal tissues to the forces generated by the aligner. The regional accents were born through the various applications of ClinCheck, spectrum of cases treated, attachment preferences, and instructions to patients. The adoption of the Invisalign System into a practice, however, is a language unto itself. It has its roots in two different tongues: biology and technology. To be fluent in all of these languages and dialects, the clinician must know the root of the language and how the dialects have been derived.

This book, the first to be written about the Invisalign System, was compiled as an educational tool for all of the languages, dialects, and accents spoken in the world of Invisalign. It is not a how-to manual. Instead, it is designed to expose the clinician to behind-the-scene elements of customization that underlie the production of Invisalign aligners. Equipped with such information, the clinician will better understand the nature of tooth movement with the Invisalign System.

Our deepest gratitude goes to the authors from Align Technology. These individuals took precious time from their daily schedules to write about the inner workings of their operation. The Invisalign System is primarily company driven; therefore, it is their contribution that makes this textbook possible. In particular, Dr Trang Duong’s indefatigability in collecting chapters from Align Technology authors is greatly appreciated. We gratefully acknowledge the monumental commitment of Align Technology, through the leadership of Amir Abolfathi, to this project. Finally, we thank Jonathan S. Simmons, whose efforts in the editing, organization, and overall preparation of the manuscript have been invaluable.
Contributors

Marc B. Ackerman, DMD
Associate Professor
Department of Orthodontics
School of Dentistry
Temple University
Philadelphia, Pennsylvania

Andrew Beers, PhD
Director of Engineering Systems
Align Technology, Inc

Robert L. Boyd, DDS
Professor and Chairman
Department of Orthodontics
School of Dentistry
University of the Pacific
San Francisco, California

Heng Cao, PhD
Research and Development Engineer
Align Technology, Inc

Jihua Cheng, PhD
Algorithm Specialist
Align Technology, Inc

David Chenin, DDS
Resident Orthodontist
Department of Orthodontics
School of Dentistry
University of the Pacific
San Francisco, California

Craig Crawford, DDS
Orthodontist
Align Technology, Inc

Mitra G. Derakhshan, DDS
Clinical Manager of European Operations
Align Technology, Inc

Trang Duong, DDS
Senior Staff Orthodontist
Align Technology, Inc

Robert Fry, DDS
Private Practice in Orthodontics
Olathe, Kansas

Paul-Georg Jost-Brinkmann,
Prof Dr Med Dent
Senior Lecturer
Department of Dentofacial Orthopedics and Orthodontics
University Hospital Charité
Humboldt University of Berlin
Berlin, Germany

Agnes A. Kan
Architect
Philadelphia, Pennsylvania

Srinivas Kaza
Product Engineer
Align Technology, Inc

Peter Knopp
Senior Manager and Product Engineer
Align Technology, Inc

Eric Kuo, DDS
Director of Product Development
Align Technology, Inc

Marc S. Lemchen, DMD
Private Practice in Orthodontics
New York, New York

Chunha Li, PhD
Manager of Materials Research
Align Technology, Inc

Vadim Matov, PhD
Senior Algorithm Specialist
Align Technology, Inc

Rainer-Reginald Miethke,
Prof Dr Med Dent
Professor and Chairman
Department of Dentofacial Orthopedics and Orthodontics
University Hospital Charité
Humboldt University of Berlin
Berlin, Germany

Ross Miller, DDS
Private Practice in Orthodontics
Sunnyvale, California

Henry I. Nahoum, DDS
Professor
Department of Orthodontics
School of Dentistry
Loma Linda University
Loma Linda, California

C. Van Nguyen, DDS
Private Practice in Orthodontics
Houston, Texas

David E. Paquette, DDS
Private Practice in Orthodontics
Charlotte, North Carolina

John M. Powers, PhD
Professor of Oral Biomaterials
Director, Houston Biomaterials Research Center
University of Texas Dental Branch at Houston
Houston, Texas
John Sheridan, DDS
Professor
School of Dentistry
Louisiana State University Health Sciences Center
Baton Rouge, Louisiana

Associate Professor
Department of Orthodontics
Jacksonville University
Jacksonville, Florida

Rene Sterental, DDS
Staff Orthodontist
Align Technology, Inc

Robert Tricca, PhD
Director of Product Development
Align Technology, Inc

Andrew Trosien, DDS
Consulting Orthodontist
Align Technology, Inc

Orhan C. Tuncay, DMD
Professor and Chairman
Department of Orthodontics
School of Dentistry
Temple University
Philadelphia, Pennsylvania

Kent Verdis
Manufacturing Process Engineer
Align Technology, Inc
Patient 7.

This 46-year-old patient desired to have the moderate maxillary and mandibular crowding corrected specifically with Invisalign. She had previously declined a four-premolar-extraction treatment by another orthodontist. Mild protrusion was present, but the patient was satisfied with her facial appearance, and her lips were competent. She had a Class I posterior occlusion with anterior crossbite of both maxillary lateral incisors. The maxillary right canine had significant loss of clinical crown length as a result of previous periodontal disease. At initial presentation, she was in periodontal maintenance and had not lost additional bone in 4 years.
Fig 25-25 ClinCheck images \((a \text{ to } e, \text{ preoperative}; \ f \text{ to } j, \text{ treatment goal})\) suggested a possible outcome with expansion and IPR.

Fig 25-26 \((a \text{ to } c)\) Note the traditional use of midline elastics. Midlines were corrected by asymmetric Class II and Class III elastics attached to the teeth on clear buttons.