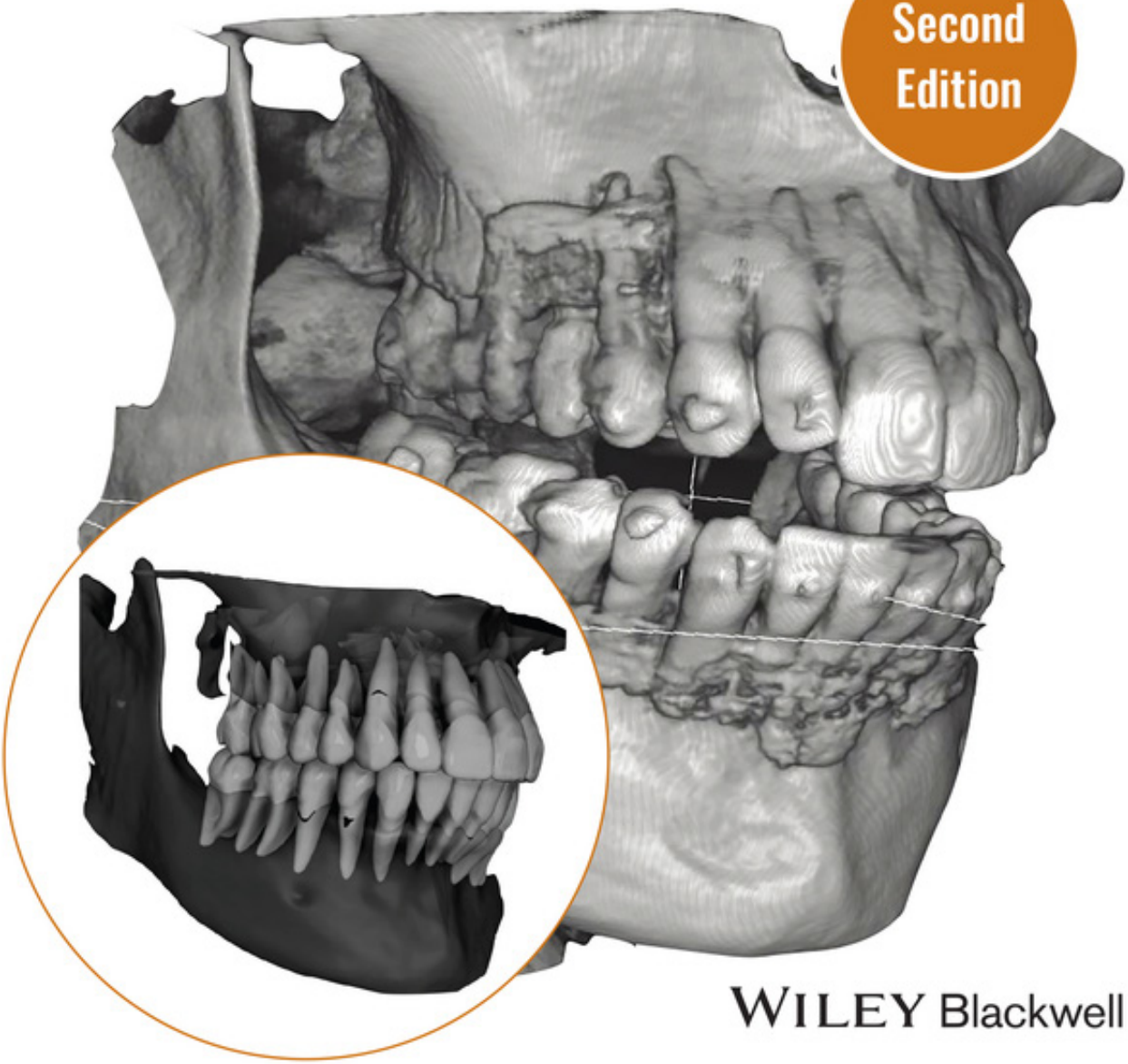
Orthodontically Driven Osteogenesis

Edited by Federico Brugnami
Alfonso Caiazzo • Simonetta Meuli

Second Edition



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Federico Brugnami
Private Practice Limited to Periodontics, Oral Implants and Adult Orthodontics
Rome, Italy

Alfonso Caiazzo
Department of Oral and Maxillofacial Surgery, Practice Limited to Oral Surgery and Implants, Centro Odontoiatrico Salernitano, Italian Society of Oral Surgery and Implants (SICOI), MGSDM Boston University
Salerno, Italy

Simonetta Meuli
Visiting Professor, School of Specialization of Orthodontics,
Catholic University of the Sacred Heart, Rome, Italy
Visiting Professor, Unicamillus International School, University,
Rome, Italy

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Federico Brugnami
To Giulia, my daughter and center of gravity

Alfonso Caiazzo
To my parents, my inspiration

Simonetta Meuli
To my sons, Giovanni and Paolo

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List of Contributors

Giulia Amodeo
UOC Maxillofacial Department
San Filippo Neri Hospital, Rome, Italy
SmileHouse Foundation, Rome, Italy

Federico Brugnami
Private Practice Limited to Periodontics
Oral Implants and Adult Orthodontics
Rome, Italy

Alfonso Caiazzo
Private Practice Limited to Oral Surgery and Implant Dentistry, Salerno, Italy
Department of Oral and Maxillofacial Surgery
Practice Limited to Oral Surgery and Implants
Centro Odontoiatrico Salernitano Italian Society of Oral Surgery and Implants (SICOI)
MGSDM Boston University, Salerno, Italy

Gianfranco Giordano
AMCO, Velletri, Rome, Italy

Sergio Marrocco
UOC Maxillofacial Department, San Filippo Neri Hospital, Rome, Italy
SmileHouse Foundation, Rome, Italy

Simonetta Meuli
Visiting Professor, School of Specialization of Orthodontics, Catholic University of the Sacred Heart, Rome, Italy
Visiting Professor, Unicamillus International School, University, Rome, Italy

Neal C. Murphy
Departments of Orthodontics & Periodontics
School of Dental Medicine, Cleveland Clinic Campus, Case Western Reserve University
Cleveland, OH, USA

Colin Richman
Department of Periodontics, Practice limited to Periodontics (Focussed on SFT, LANAP/LAPIP/Oral-Systemic-Condition), Diplomate, American Board of Periodontology, Augusta University, Augusta, Georgia, USA

Domenico Scopelliti
UOC Maxillofacial Department, San Filippo Neri Hospital, Rome, Italy
SmileHouse Foundation, Rome, Italy

Introduction

Improving orthodontic treatments by minimizing side effects and broadening their range has been a top priority for clinicians and researchers. Corticotomy, an established technique, has recently gained increased attention. However, confusion and misinterpretation surrounding the term, its application, and its benefits have led to global horizontal (pioneers worldwide) and low vertical diffusion (members of the same society). This underscores the need for a dedicated book on corticotomy or Periodontally Accelerated Osteogenic Orthodontics®. The introduction to the first edition, written 10 years ago, remains relevant today. Despite yearly evidence demonstrating the procedure's effectiveness and safety, orthodontic attention remains unchanged, shifting focus to 3D Digital Planning and Clear Aligners. The preferred terms used to describe the procedures have also evolved, with corticotomy-facilitated orthodontics (CFO), accelerated osteogenic orthodontics (AOO), and selective alveolar decortication gaining preference. Orthodontically driven osteogenesis (ODO), or the ability to grow new bone, is now favored over regenerative. The osteogenic potential, combined with bone grafting, can expand basal bone. This leads to two positive effects: less extraction of healthy premolars in growing patients and a more robust periodontium that prevents recessions during orthodontic movement. This concept initiates tissue engineering in orthodontics, where orthodontists and dental surgeons should define themselves as dentoalveolar orthopedists and embrace this new treatment philosophy. This approach maintains the promise of a faster orthodontic treatment and expands the limits of a safer one. It also offers a sound alternative to more invasive procedures, such as orthognathic procedures and can even modify the lower third of the face. This is impressive for a localized periodontal surgery when correctly combined with orthodontic treatment.

Orthodontically Driven Osteogenesis and 3D Digital Planning: New vs Innovation

As per the principles of innovation and change, "technology transfer" encompasses all activities that result in any user adoption of a new product or procedure. The term "new" here denotes any improvement over existing technologies or processes rather than a recent invention. Technology transfer necessitates active interaction between technology sponsors and users, which leads to actual innovation. It is crucial to differentiate between innovators or early adopters and late adopters. Innovators are individuals or groups willing to take risks by adopting new methods, products, or practices not widely used. They provide practical evidence that an innovation works, which is vital for later adopters.

Conversely, diffusion refers to the spread of an idea, method, practice, or product throughout a

social system. There are various kinds of technology transfer, including horizontal transfer (the movement of information on technology between innovators within an organization or between similar organizations) and vertical transfer (the movement of information on technology from innovators to late adopters of an organization or system of organizations).

ODO has been increasingly successful worldwide, resulting in extensive horizontal diffusion. However, paradoxically, the highest percentage of orthodontists in any developed country will either ignore or be skeptical of ODO and fail to present it to their patients as a viable and valuable alternative due to a lack of vertical diffusion. There are different reasons to explain this difference in diffusion, but it is important to note that natural resistance to change is just one factor.

1) The innovation is not disseminated. Given that the "innovation" is truly innovative, one of the most important driving factors is the economical one. For example, most of the innovations in dentistry in the last 30 years, from implants to membranes to clear aligners or straight wire, have been "encouraged" by suppliers and manufacturers. It is the same as in the pharmaceutical business: any revolutionary drug to cure a rare syndrome would suffer a difference in diffusion compared to Viagra® or Biposphonates or Statins.
2) The innovation is disseminated to the wrong people. The information is not referred to the proper person or somehow gets lost on the way.
3) The innovation is not understood by the potential user.

Most of the time, this is created by a superficial knowledge of the technique or misinterpretation, lack of homogenous terminology, and underestimation of potential benefits.

3D digital planning may be the correct driver for the diffusion of ODO: It becomes more difficult to ignore when the roots extend beyond the original bony envelope.

Federico Brugnami, Alfonso Caiazzo,
and Simonetta Meuli

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Orthodontic Tissue Engineering: A 20-Year Retrospective and Philosophical Polemic©

Neal C. Murphy

Clinical Professor, Departments of Orthodontics & Periodontics, School of Dental Medicine, Cleveland Clinic Campus, Case Western Reserve University, Cleveland, OH, USA

Dedication

This chapter is dedicated to Professor Spiro Chaconas, Founder and Chairman Emeritus, Section of Orthodontics, UCLA School of Dentistry. Professor Chaconas, presently enjoying a well-deserved retirement in Sothern California, was an exceptional leader, friend, and mentor for over three generations of orthodontists at UCLA. He taught his protégés to enter private practice with confidence and engage the inevitable vicissitudes of our careers – many rather brutal – with professional élan, stoic indifference, transcendent vision, and personal humility. We did.

Thank you, Spiro.

Introductory Rationale

Since 2001, this author – dual-certified in both orthodontic and periodontic – has collaborated with a number of orthodontists and periodontists in an effort to engineer a novel alveolus bone that could accommodate the full complement of human dentition. This was attempted to liberate a naturally "full" smile from the strictures of skeletal malalignment and so-called arch length deficiencies. By the year 2023, we were able to develop protocols that achieved that goal and accelerate the rate of tooth movement three to fourfold. In addition, instances of pernicious side effects like apical root resorption and periodontal attachment loss were predictably minimized or nonexistent compared to traditional edgewise therapies. In that regard, our protocols, both surgical and nonsurgical in a phrase, proved to be "faster, safer, and better." These revelations were brought into high relief by a 20-year retrospect as attested to by studies cited herein.

Orthodontists' attempts to enhance the esthetic value of the patients' lower face are indeed laudable goals. However, the widespread popularity of extraction therapy presents a sobering challenge because it notoriously has been haunted by the unfortunate and unpredictable side effects of premature lower face aging and unsightly flattened (so-called "dished-in") profiles in maturity. Moreover, since these unsightly facial profiles often become most apparent years after active therapy has ended, they are subtle assaults on facial beauty. While evident to the general population, the iatrogenic deformity presents a pattern that is vaguely unsightly but

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nondescript to laymen. This chapter explains that cell- and tissue-level biology is often ignored in orthodontic curricula and sacrificed by inordinate preoccupations with gross anatomy. But periodontology revels in cell-level dynamics and affords us, as specialty science integrators, to reveal a universe of new orthodontic science, we call "orthodontic tissue engineering (OTE)."

If dentists claim a desire for "best care," we must ask how one defines that superlative term. By definition, a superlative is an absolute, and whatever treatment most closely approximates that ideal is reasonably argued as "best." Is "best care" which is predictable, fastest, with fewest pernicious side effects, least painful, most stable, and most compatible with contemporary cultural values?

This chapter is an attempt to organize a compelling rationale for this new protocol in terms of the underlying cellular dynamics that allow it to achieve case outcome stability superior to the very unstable outcomes that are predictably disappointing in traditional care. Ironically, the new concept of "accelerated orthodontic therapy" was met with political opposition and excessively cynical skepticism by established practitioners. Yet truth prevails and the luddites and clinical nay-sayers of the 20th century were proven wrong by 21st-century science. This chapter boldly addressees this controversy as a tribute to intrepid clinicians who preceded us and as a scientific reminder that hard data and scientific epistemological inquiry, however, disruptive to prevailing thought and wishes, will out.

This definition seems sensible to us. Therefore, the aim of this chapter is to describe the ramifications of an emerging perspective and clinical protocol in those terms. Although unheard of by some, the subject is neither new nor novel because it has been evolving over time within the ebb and flow of scientific evolution. It nonetheless brings disruptive issues and protocols that are certainly more predictable, faster, with fewest pernicious side effects, less painful in adjustments, more stable, and more compatible with contemporary cultural values than traditional extraction alternatives. The problem with science is that it has no master. So, it flies in the face of convention and traditional bias.

Late 20th-century science has delivered a collection of empirical observations and corticotomy protocols that are embodied under the collective rubric, surgically facilitated orthodontic therapy (SFOT) which in this book will be called orthodontically driven osteogenesis (ODO). This term referring to a particular histological reaction, subsumes a number of protocols that are mere variants of the same basic biological phenomena. These terms include but are not limited to "selective alveolar (-us) decortication" (SAD), decortication without a bone graft, "stem cell orthodontic therapy" (SCOT), "stem cell alveolar therapy" (SCAT), "corticision" when a scalpel is used, "accelerated osteogenic orthodontics" (AOO) where a bone graft is combined with SAD, "periodontal(ly) accelerated osteogenic orthodontics" (PAOO) synonymous with AOO, and here, "orthodontic tissue engineering" (OTE) referring to a 21st century protocol focusing on permanent alveolus bone phenotype alteration. We posit that emerging periodontal sciences, the biology of healing bone, and cell-level biology, which underlie ODO, are as integral to orthodontics, as civil engineering is to good architectural design. ODO is an example of the clinical science of engineered morphogenetic bone modeling – pioneered by the Russian orthopedist Professor Gavriil Ilizarov – synthesized with traditional orthopedic biomechanics (Figure 1.1). This Russian orthopedic surgeon proved beyond doubt and under great oppression that bone is malleable and can be reshaped to a more physiological form at will. That principle applies to the alveolus bone as well (Figure 1.1).

We pose a challenge to traditional biomechanics to enhance clinical efficacy, ameliorate pernicious side effects, and advance the orthodontic specialty beyond the strictures of simple mechanical art. The issues discussed in this

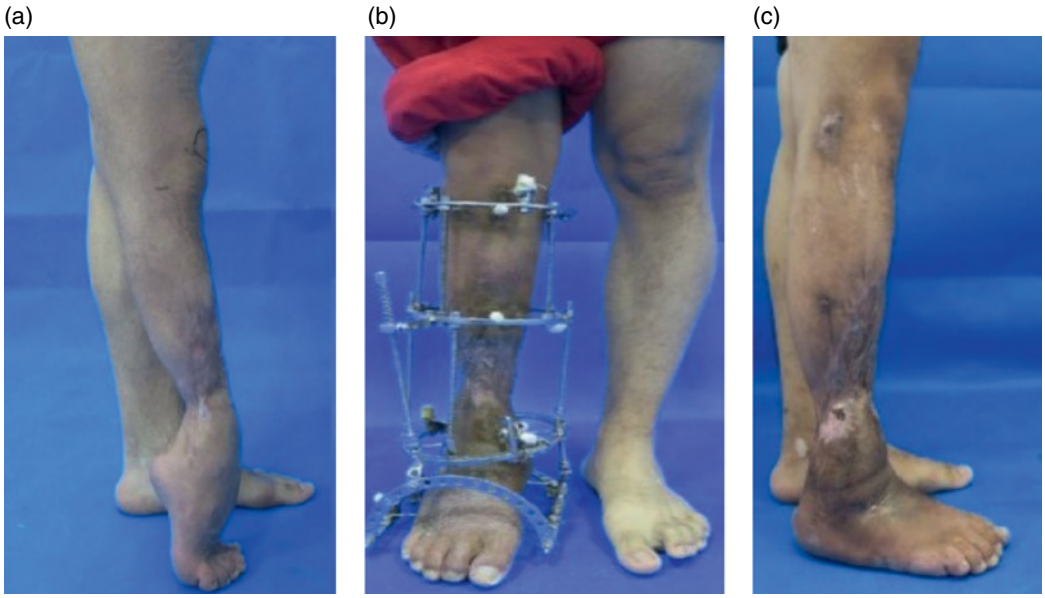

Figure 1.1 This treatment demonstrates what can be done to correct a deformed long bone. The same principle used by Gavriil Ilizarov can be applied to the alveolus bone in correcting dentoalveolar deformities. The leg deformity in (a) represents a deformed bone. (b) The Ilizarov orthopedic device with his surgical protocol can lengthen long bones at the rate of 1 mm/day. (c) Demonstrates an improved esthetic appearance and function. This is what OTE attempts to do with the dental alveolus bone. *Source:* Dong *et al.* (2021)/Reproduced with permission from Tsinghua University Press Ltd.

polemic are based on the dual-certified author's 50 years of integrating periodontics and orthodontic in an urban private, but academic, practice and 20 years of understanding ODO. It also reflects the combined work of a growing global community of biologists and dentists, formally trained, or passionately interested in reengineering the mass and shape of the foundation of the human dentition. Hence, we write in the first-person plural, not to imply lock-step concordance, but rather a general agreement that is compatible with a wide variety of readers. Some repetition will be noticed in this discourse, but that serves as an intentional pedagogical device. The subject matter is quite novel to some readers because we employ a technical prose of molecular biologists, tissue engineers, periodontists, and orthodontists. Moreover, repetition of a new concept within several different contexts can only enrich the conceptualization. Hopefully, the literary device will edify and not distract.

Our objective here is not to proselytize but rather to serve examples of what *can* be achieved by others who wish to minimize extraction therapy side effects. But we hope this is received in a provocative manner to stimulate a meaningful dialectical exchange rather than contentious debate, misinformation, distortions, and misrepresentations that have marred the development of this topic. What is practiced by others is beyond our scope of control. So, we do not call for the immediate condemnation of those who are uncomfortable with protocols presented herein. We focus on scientific advances in ancillary biological fields too fascinating to ignore. And, these innovations can serve as both a beacon and safe harbor for those who are dissatisfied with the limits of the *status quo*. We are here to show a better path but only for those who wish to embark upon it.

We do not seek to condemn legitimate extraction therapy categorically, but we are intentionally provocative about the perfunctory use of