Practical Applications in Dental Occlusion

Analog to Digital

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Contents

See the Notes section for more background and context for the concepts in this book.

Foreword

Occlusion is one of the most confusing topics in dentistry. It has been taught over the last three-quarters of a century almost like religion. There is a "right way," which is the way the person teaching it describes it, and then the "wrong way"—anything other than what is being taught.

The good news is that the rigidity of some of the early approaches to occlusion have weakened. Research has shed light on the relationship of the occlusion to joints, muscles, and parafunctional activity. The challenge becomes how to now identify what is factual about occlusion and how that knowledge will influence patient care.

Dr Michael Radu has been practicing dentistry for over 40 years and has lived through the dilemmas created from the beliefs about occlusion. He is also a consummate student, who has exposed himself to varied beliefs by studying occlusion with several different individuals.

Dr Radu is also an excellent thinker. In this book, *Practical Applications in Dental Occlusion*, he recognizes that there are many facets to understanding and working with occlusion. It is, as he states, "a multifactorial topic."

His goals for the reader are to make occlusion practical and manageable, understanding that an appropriate occlusal therapy for some patients is not applicable to all patients. He accomplishes this masterfully by walking the reader through each facet of thinking about occlusion and then by evaluating how that thought process would alter the clinical treatment of the occlusion.

Along with practical language, the book contains illustrations that clarify the concepts being written about to make it easier for the reader to visualize what is being discussed, be they the relationship of the occlusion to the joints or the relationship between the teeth themselves in the different positions of the maxilla and mandible.

I am confident that if you read this book and allow yourself time to analyze what Dr Radu is describing, your understanding of occlusion will increase significantly, as will your competence and confidence in analyzing and managing occlusion for your patients.

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Preface

Personally, I'm always ready to learn,
although I do not always like being taught.
– Winston Churchill

Occlusion is often boiled down to the "tap, tap, and grind" of articulating paper marks we perform daily as practicing dentists. Our appointments each day are littered with fillings, single crowns, bridges, or more extensive fixed prosthodontics work. And for 90% of those appointments, we are able to ignore occlusion entirely until it's time to get out the articulating paper at the end of the appointment. Tap, tap, and grind. Drill the red marks. "How does that feel?" Tap, tap, and grind. Drill the red marks. "Don't worry; you're still numb and you'll get used to it." There is inherent adaptability in the stomatognathic system, which helps us even when we don't quite understand how to perfect the occlusion.

After all, 90% of the time, we can reduce the concept of occlusion into a consideration of the patient's current bite. We just have to adapt our treatment to that. But for the other 10% of the time, this approach will get us into big trouble. Sometimes the patient's current bite won't let us complete our treatment, at least not successfully in the long term. But if you don't know how to set up occlusion outside the patient's existing bite, what are you supposed to do?

Unfortunately, "occlusion equals confusion" is the catchphrase frequently repeated among dental students, and that attitude carries over into clinical practice. But occlusion doesn't have to be confusing. Not really. Not if you're taught how to understand and manipulate it. And that's where this book comes in—to teach you a simplified concept of occlusion that can help you perform predictable and successful treatment and avoid costly mistakes.

The book is divided into two parts:

- Part 1 outlines guiding principles and a simplified model of occlusion.
- Part 2 features specific situations you will come across as you diagnose, treatment plan, and treat your patients' cases.

A supplementary Notes section at the end adds a layer of theory and addresses the "yes, but there is more to it" concern.

My quest is to approach occlusion as a biologic system, uncover governing principles, and create order in a world of confusion. Occlusion doesn't have laws, models, and formulas like those found in mathematics and physics, but I draw from great thinkers like Pankey, Dawson, Spear, and Slavicek to provide you with simplified protocols you can adapt to your preferences. Let's ditch the indoctrination and controversy that plague our profession and focus on what we can achieve when we think well.

Patients come to us for many reasons. Sometimes it's clear what is needed, like a filling, while other times there is pain that we need to figure out and manage—or everything is broken down. Sometimes patients just want their teeth to look different. In all of these scenarios, we need to decide whether to keep the existing bite—the status quo—or change it. Most of the time we can help our patients without changing the bite. Sometimes we should change it, but we choose not to because it seems easier. And sometimes it is clear we need to change it. But do we let the patient determine the maxillomandibular position (ie, show us where they feel comfortable), or do we apply scientific principles to find the physiologic maxillomandibular relationship? At the end of the day, we need to answer three questions:

1. Do we keep or change the bite?
2. How do we change it if we need to?
3. How do we record the new maxillomandibular position for the lab?

This book will empower you to answer all these questions, every time. After reading this book, you will understand occlusion techniques using analog and digital workflows, including the following concepts:

- How to analyze occlusion
- How to decide to keep the existing bite or change it
- How to find the physiologic mandibular position when you need a new one
- How to record the new mandibular position for the lab
- How to integrate occlusion into your treatment plans

I hope this book helps to clear the muddy waters of occlusion and leaves you feeling confident and emboldened to treat your patients.

Acknowledgments

"A man will turn over half a library to make one book."
– Samuel Johnson

It is my pleasure to express my deepest appreciation to those who helped me craft this book.

The first to mention is Leah Huffman, the editorial director at Quintessence Publishing. Leah was the smart and tough developmental editor who worked hard through multiple drafts to sharpen my messages. Thanks to her superb editorial instinct and clear vision, this is a much better book than it would have been otherwise. I owe her a ton of gratitude.

This book is also a result of having great mentors, such as Klaus Pfeiffle, Peter Dawson, and Frank Spear, to whom I owe most of what I know.

The book would have remained a perpetual project without Michael Noczinski and Gary Holland. Michael is my German master dental technician and partner in occlusion. We worked together for about 30 years, even after I crossed the pond. For years, he told me to stop talking about occlusion and just "write the book already." My dear friend Gary Holland, a successful businessman and fine intellectual, nudged me with his soft approach to commit to write what I was explaining to him and others about occlusion.

Lee Culp, my other incredible laboratory artist, was instrumental in developing my digital workflows.

My friends from the Scientific Investigation Committee of the American Equilibration Society deserve a big thank you. Our debates opened new perspectives and developed my thinking. Thank you Warren Jesek, Jette Holbrook, Jack Marincel, Scott Alman, and Keith Kinderknecht.

My colleagues in the Prosthodontics Department at Nova Southeastern University College of Dental Medicine shaped my knowledge and helped me meet and teach many students eager to learn why occlusion doesn't have to equal confusion.

Thank you to my closest dentist friends who read parts of the manuscript and helped me understand what wasn't clear enough and needed

improvement: Irina Dragan, Radu Dogarescu, Titel Sufana, Anca Ralsen, and Marius Catiche.

A special thank you to Flavius Toma and Mircea Marandici, my engineer and scientist friends who verified my physics and the general principles guiding occlusion. Mircea deserves a very special thank you for co-authoring my article on the math of centric relation and distilling my intuitions into a simple formula. Our conversations are a source of inspiration, and it is amazing how much I learned from a non-dentist about occlusion.

My son Daniel is the one I have to thank the most for his contribution to this book. Our daily conversations, his deep and inquisitive thinking and skills in all things digital, and his help in refining my ideas over the years we worked side by side all helped shape this book. When we started to work together 8 years ago, he was the new dentist I was tailoring my writing for. He convinced me that besides knowledge, a dentist needs protocols. Later, my daughter-in-law Kristina became the new young dentist who showed me even more ways I would need to refine my message, and I thank her for her help.

Another group I have to thank are my patients and the incredible staff members of my dental practice—Tina, Laura, Jessica, Sharon, and Kim—my "work family." My growth as a dentist would have been stunted without their tolerance for my incessant desire to improve dentistry and try new techniques even when it meant extra work. They endured my passionate monologues and recurring frustrations with the status quo and heard me say the same thing a thousand times, with ever-so-slight differences along the way. Those differences are what refined my messaging and led to this book and its simplification of concepts.

Last but not least, I owe a lot to my family. My wife, Magda, and my sons, Michael and Daniel, have supported me and given me strength, even when that meant being away from them more than I liked. I have to thank Magda for allowing me to toil away for hours on end, both at work and at home, all to pursue my professional ambitions. She was always a bastion of strength in taking care of our sons and our home, all while having her own career.

This book is a work of love for my profession, patients, colleagues, students, and family. To all I owe my heartfelt gratitude.

About the Author

Michael Radu, DDS, MS, is a dentist who has practiced for over 40 years in three different countries across two continents. He believes strongly that his work is to help dentists with occlusion in their practice, so he lectures and educates his fellow dentists every chance he gets. He believes in science above all, which is why occlusion lies so close to his heart and why this book relies so heavily on the laws of physics. After all, Einstein explained how his relativity theory came from big scientific postulates, not from experiments, which may be biased, flawed, or misinterpreted.[1] Michael Radu also believes in the power of mentorship and the importance of sharing ideas to achieve new levels of understanding. Beginning with his physics professor in college and stretching to Klaus Pfeiffle and Michael Noczinski in Germany, Peter Dawson and Frank Spear in the United States, and the coterie of dentists at the American Equilibration Society, the support and positive challenges he was given have shaped his scientific approach to occlusion. In his eyes, the simplest, most irrefutable evidence is mathematics. When we think in terms of stability, vector of force, angles, and alike, we are less prone to make mistakes. Dentists will always prefer to work in the existing occlusion because no changes seem safer than the alternative, but Michael Radu challenges this notion and implores his colleagues to understand the scientific principles underlying the concept of occlusion so they can better care for their patients.

1. Einstein A. Induction and Deduction in Physics. Berliner Tageblatt. December 25, 1919.

PART ONE

1

Why Do We Need Occlusion?

Occlusion seems complicated because it is a system with multiple parts, and our brains struggle to conceptualize and understand complex systems. As scientists, we want to understand the big picture of the whole concept, but as practicing dentists we need to figure out the details and identify an algorithm of steps to follow. This tension between the big picture and the details reflects how the right and left sides of our brain function,[1] and solutions to particular problems are only found when we get both sides working and integrate the details back into the big picture.

Occlusion: A Multifactorial Topic

Occlusion is a complex concept influenced by many problematic factors, as illustrated in Fig 1-1 and described in the following sections. This book acknowledges the problems and offers real solutions.

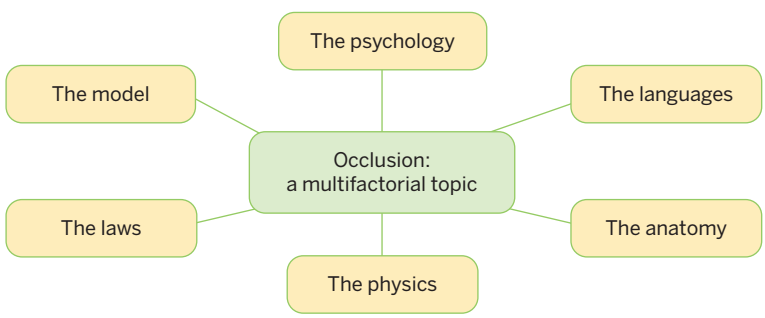


Fig 1-1 Mind map of occlusion.

The psychology of occlusion

PROBLEM: Our minds drive our behavior; essentially we become what we think about.[2] We fear the unknown, and occlusion is one of those topics dentists struggle to grasp fully. We learn about it in dental school, but we're still hazy on it when we graduate, and we're able to avoid it in practice by following certain rules: *(1)* don't change it; *(2)* if it's not broken, don't fix it; and *(3)* the patient will get used to it. But sometimes we actually do need to change it, we have to fix it before it breaks further, and some patients don't get used to it.

SOLUTION: This book presents protocols to combat the fear of the unknown.

The languages of occlusion

PROBLEM: Occlusion means different things to different fields of dentistry. In restorative and prosthetic dentistry, we change the tabletops of teeth to make them fit precisely together. In orthodontics, we move teeth to make them fit together, with some settling and adaptation. In maxillofacial surgery, we move jaws and alter joints to make the teeth fit again, often with some orthodontics or restorative dentistry along the way. In operative dentistry, we keep the existing occlusion and make sure that we don't change it inadvertently. In periodontics, we usually keep the existing occlusion or perfect it to reduce the forces applied to certain teeth. In orofacial pain, we try to alter the occlusal patterns using an oral appliance.

Our terminology is at times a problem. Some terms are the same, some are different, some terms mean different things to different specialties, and some terms are dated but still being used in one specialty but not another. We speak different languages, and sometimes we need an interpreter.

SOLUTION: This book simplifies the terminology and seeks common denominators (see Note B).

The anatomy of occlusion

PROBLEM: Occlusion is a structured system with its own anatomy and internal workings. We need to understand how the system works to identify practical workflows for adjusting or recreating a patient's bite, but oftentimes this understanding is lacking. When we realize that occlusion is a structured system with commonalities and differences in individuals, we can better manage our clinical cases.

SOLUTION: This book shows how the system works and how to use it in practice.

The physics of occlusion

PROBLEM: We went to school to become doctors of dentistry. As such, we had to learn about the anatomy, biology, and neurophysiology of the human body, particularly the stomatognathic system. Once we had the scientific knowledge down, we had to learn how to use our hands to accomplish the fabrication and procedural work of dentistry. But dentistry is more than life sciences and art. As much as we want to solve medical issues for our patients, we need to acknowledge that biomechanics and physics have a huge role to play in our patient's mouths, especially when it comes to occlusion. And many of us did not become dentists to practice physics, so we have to learn it.

SOLUTION: This book presents a formula for occlusion that simplifies, quantifies, and creates a model to aid understanding of complex issues.

The laws of occlusion

PROBLEM: Occlusion has general laws and rules such as stability and adaptability, and the laws of physics also come into play when discussing occlusion. We need to work within these laws and stop trying to explain things superficially. For example, "the patient cannot tolerate a change in occlusion because of the personal stress" is an opinion, not a fact based on any scientific laws. A good occlusion must be stable—that is, it must be able to withstand the forces it is subjected to. We should never assume stability, but we often do.

SOLUTION: This book explains the laws of occlusion responsible for success in treatment and discusses the factors that influence stability. It presents checklists and protocols to ensure practical application of these principles.

The model of occlusion

PROBLEM: Any concept or system, no matter how complex, becomes more clear and understandable when we have a model to visualize it. Occlusion can be visualized as several models: a horizontal door, a tripod, a multilegged chair, or a mathematical formula containing its defining parts. But everyone thinks differently and processes information differently, so you need to find a model that works for you.

SOLUTION: This book presents all these models and suggests a few thought experiments to guide the reader in understanding.

Why Do We Need to Understand Occlusion?

There are three main reasons why we need to understand occlusion[3] (see Note A):

1. To decide which occlusion we should work in
2. To record it for the laboratory
3. To manage all the forces at play

First, we need to decide if we can work in the patient's existing occlusion or if we need to change it. In some cases there is no occlusion at all and we need to decide how to create one.

Second, we need to record and transmit the clinical situation (the "bite") to the laboratory so they can accurately fabricate the prosthetic pieces.

Third, we need to manage the forces applied to the existing teeth or newly created restorations to ensure stability and longevity. Occlusion is all about forces applied to teeth and other structures, and excessive forces are a potential pathogenic factor. In designing or maintaining the existing occlusion, we cannot forget about germs and the role they play in dentistry. We always need to prevent the overgrowth of bacteria by facilitating adequate hygiene access. Daily dentistry is really a study in germs and forces.

What Dentists Really Need

As dentists, we want to be able to apply consistent techniques and know exactly what to do in all clinical situations (Fig 1-2). That starts with the occlusal examination, diagnosis, and treatment planning and continues with the recording of the occlusion for the lab. In many branches of medicine, protocols have become the norm. They do not constrain the clinician to a set sequence but rather remind the clinician of the steps to be taken. Checklists are especially helpful in this regard.[4–6] In this book, a protocol or technique is presented for

Note: In this book, a protocol or technique is presented for every aspect of occlusion a dentist is responsible for. Because we cannot easily measure if we got the right bite, we need to apply step-by-step protocols to achieve the desired result.

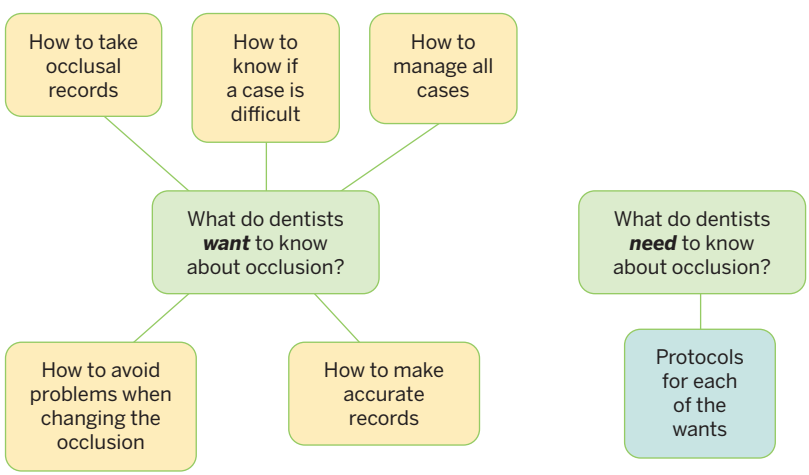


Fig 1-2 Mind map of the wants and needs of dentists regarding occlusion.

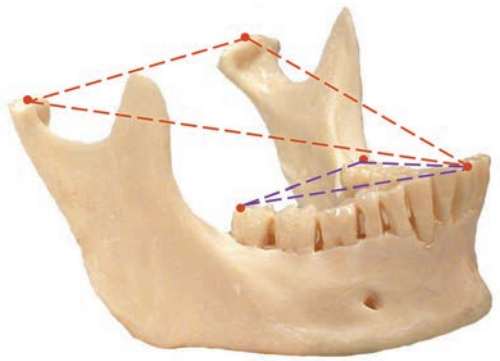


Fig 3-3 A smaller tripod using ARP and the position of the second molars *(purple)* can be used to substitute for the larger one (ARP and the condyles, *red*) and indirectly record CP and MP.

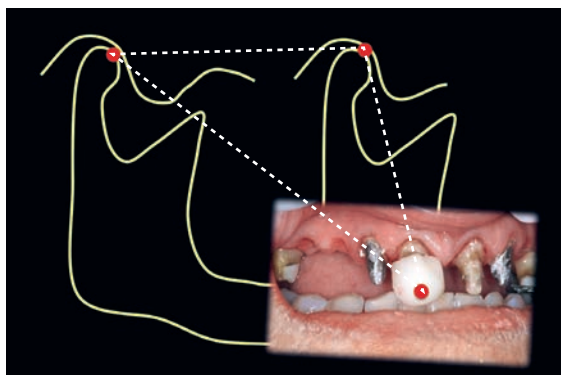


Fig 3-4 An anterior stop can be used to create a stable tripod using the condyles when there is no IC.

Fig 3-5 Three points on the mandibular occlusal rim are sufficient for a stable interarch record.

Fig 8-53 VDO measured with provisional restoration in place.

Fig 8-54 An approximate composite (Triad) stop was created over the two most anterior implant abutments.

Fig 8-55 *(a)* The VDO is measured with the composite stop, which will be adjusted to reproduce the desired anterior restorative space. *(b)* In this case, composite was added to the initially fabricated stop because the provisional restoration had a larger VDO.

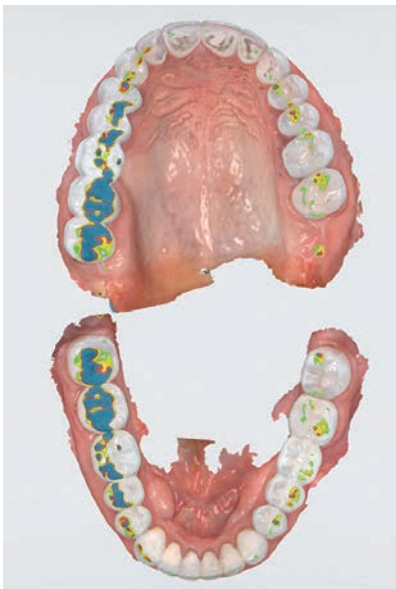


Fig 9-6 The IC 11 months later; note the heavier contacts on the right.

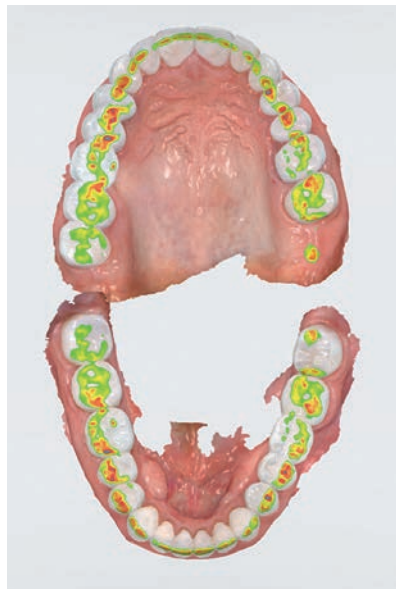


Fig 9-7 IC after reducing the heavy contacts.

Fig 9-8 Frontal view of IC at 11 months.

Eleven months later she was checked again. She reported that she had no symptoms but that the bite felt heavier on the right side. The scan showed that she was correct (Fig 9-6), so we reduced the surfaces of contact, and 3 months later she once again reported that everything was perfect (Figs 9-7 and 9-8).

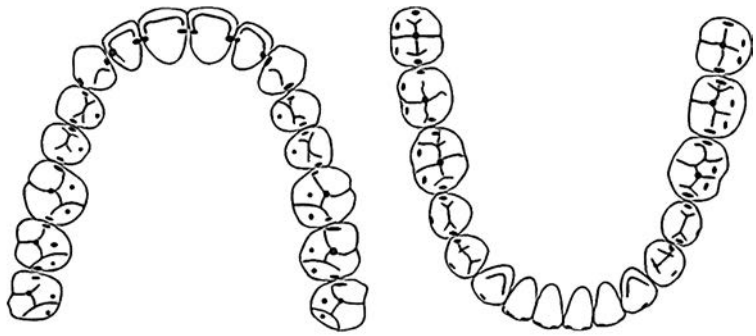
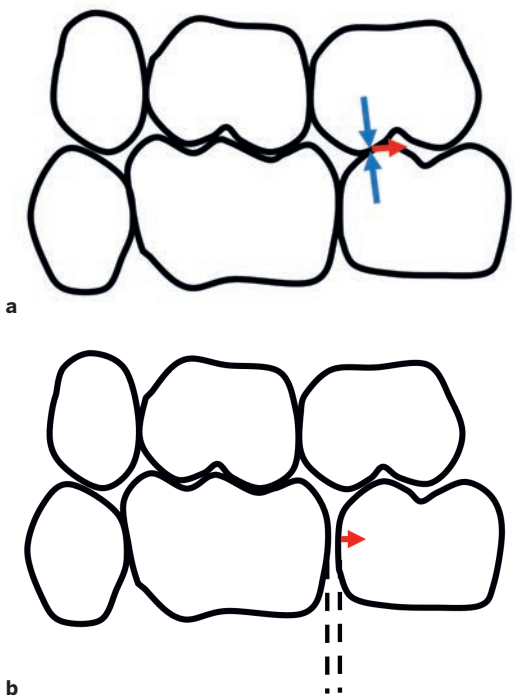


Fig 9-9 Ideal occlusal contacts.

Fig 9-10 *(a and b)* Contact on the mesial aspect will cause the most posterior tooth in an arch to migrate distally and open the contact point.



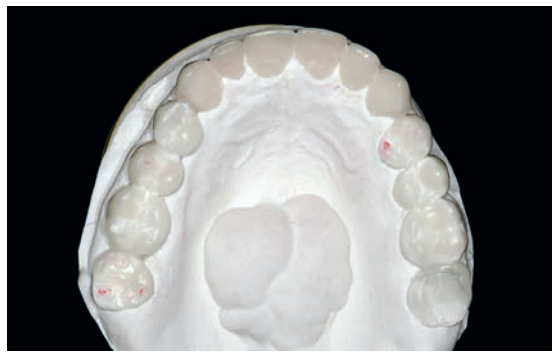


Fig 10-4 A wax-up restores the anatomy and function of the maxillary teeth in CR.

Fig 10-5 Provisionals fabricated intraorally.

Fig 10-6 The anterior guidance is adjusted in harmony with the EoF.

and adjusted in CR using a leaf gauge or bimanual manipulation. The anterior guidance must be established precisely in order to reproduce it in the final restoration (Fig 10-6). In the case of a full-arch preparation, all excursive movements are adjusted to achieve simultaneous centric stops

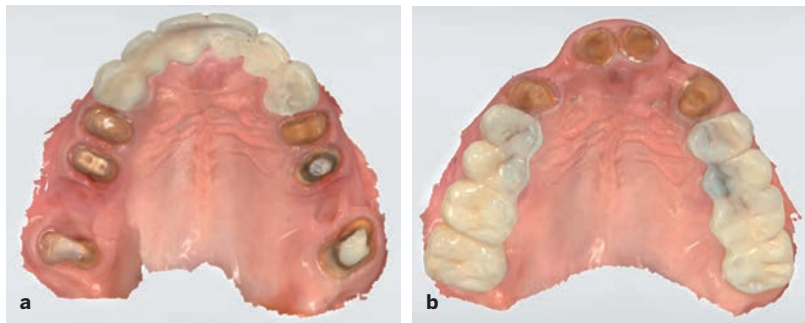


Fig 10-12 *(a and b)* Segmental scans are taken to allow matching of hard structures (teeth and provisionals).

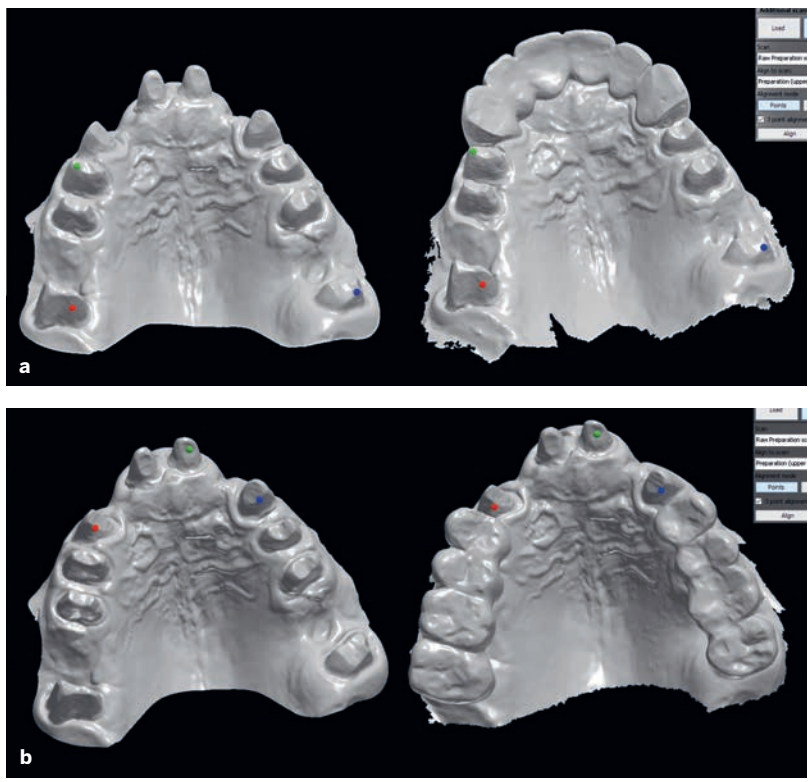


Fig 10-13 *(a and b)* The segmental scans allow the lab a precise matching of hard structures rather than using soft tissue points.

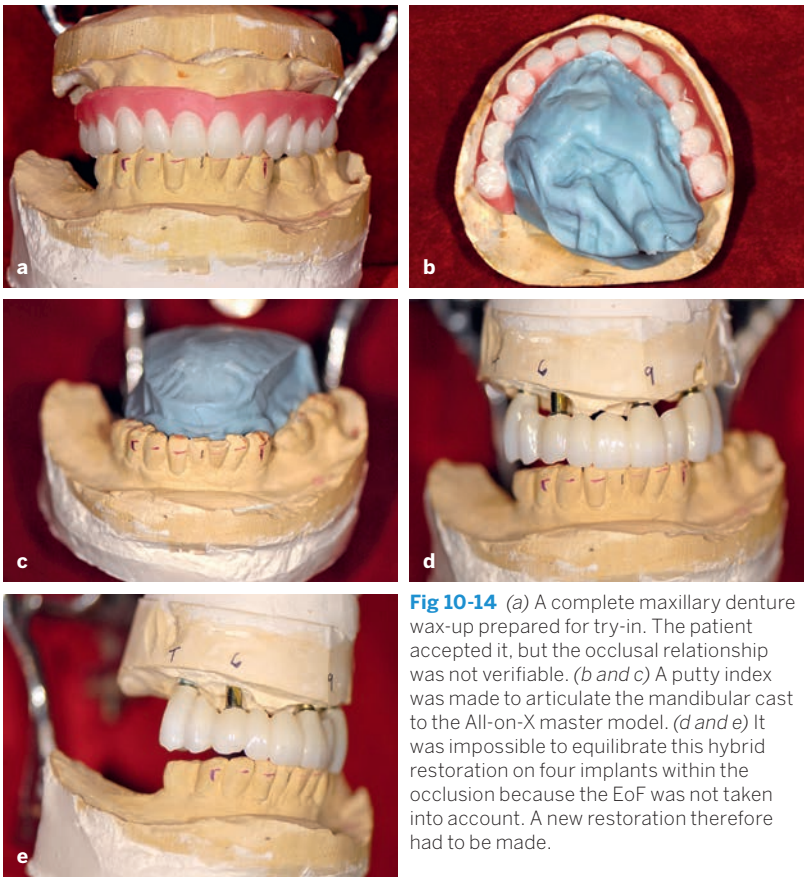


Fig 10-14 *(a)* A complete maxillary denture wax-up prepared for try-in. The patient accepted it, but the occlusal relationship was not verifiable. *(b and c)* A putty index was made to articulate the mandibular cast to the All-on-X master model. *(d and e)* It was impossible to equilibrate this hybrid restoration on four implants within the occlusion because the EoF was not taken into account. A new restoration therefore had to be made.

Recording EoF in Edentulous Cases with Implants

Provisional denture

Similarly to the edentulous cases described above, a trial or provisional denture can be used—with limitations. In cases of immediate loading of the implants with a provisional screw-retained restoration, the options are better. In these clinical situations, we can change or adjust the provisional restoration to the patient's EoF and copy it for the final restoration.

However, due to the difficulty in creating a functional provisional denture, dentists often resort to an approximate one, expecting the laboratory to mimic a good-looking setup of a denture. Figure 10-14 shows

Fig 10-17 The intraoral scan of the intaglio surface is merged with the customized EoF embedded into the provisional scan to fabricate a final restoration.

has healed, a surface intraoral scan of the tissue and of the perfected provisional restoration is taken and merged with the initial implant position scan for fabrication of the final restoration (Fig 10-17).

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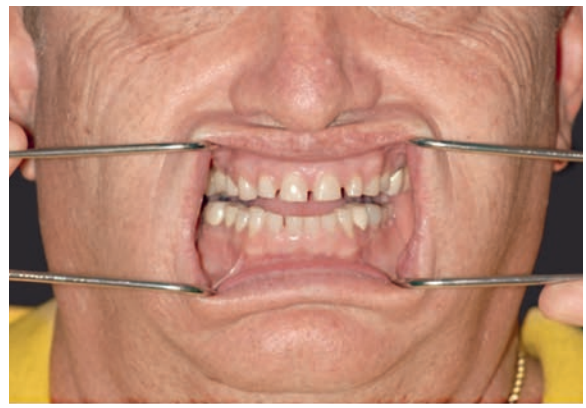

Fig 11-3 Photograph with retracted lips to relate the face to the intraoral scans.

11. Customization of provisionals in closure and excursions and verification of function and esthetics
12. At a subsequent appointment, confirmation of the patient's likes, dislikes, and function, with adjustment as needed
13. Impressions or scans of customized provisionals for the lab
14. Facebow record or facial scan
15. Shade-taking with photography, as well as detailed color mapping with surface texture
16. Photograph of face with retracted lips to make merging of the scans and 2D photograph possible (Fig 11-3).

Technician

17. Creation of the analog or digital patient; the technician now has all the patient's information at their fingertips: face, smile, preparations, opposing model, interocclusal registrations at the desired MP, customized provisionals reproducing the EoF, desired shade, and surface texture
18. Fabrication of the final restoration

Dentist

19. Delivery of the final restoration: Verify and adjust occlusion if needed. Be sure to confirm the patient's acceptance before permanent cementation.