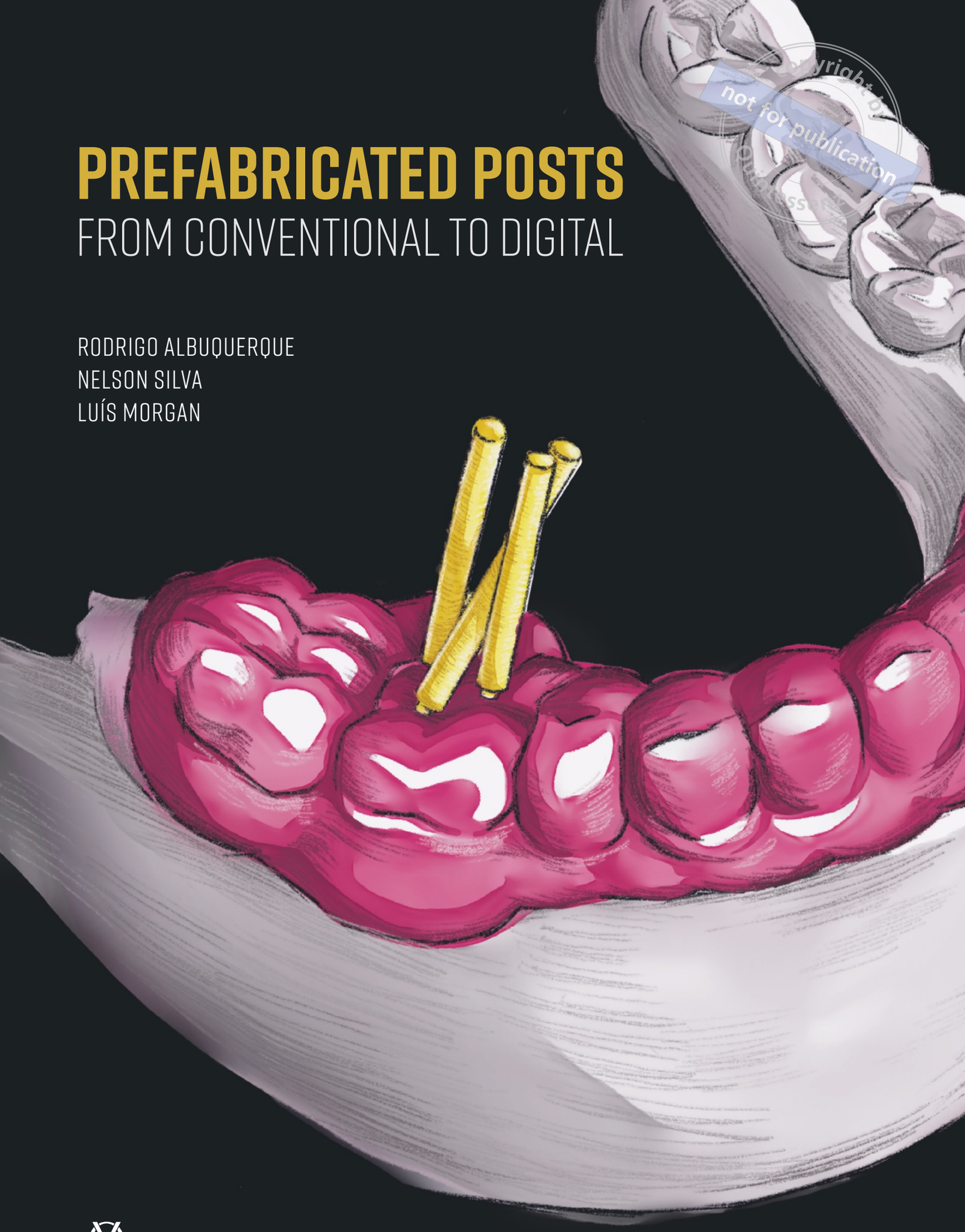
PREFABRICATED POSTS
FROM CONVENTIONAL TO DIGITAL

RODRIGO ALBUQUERQUE
NELSON SILVA
LUÍS MORGAN



QUINTESSENCE PUBLISHING

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PREFACE

The gift...

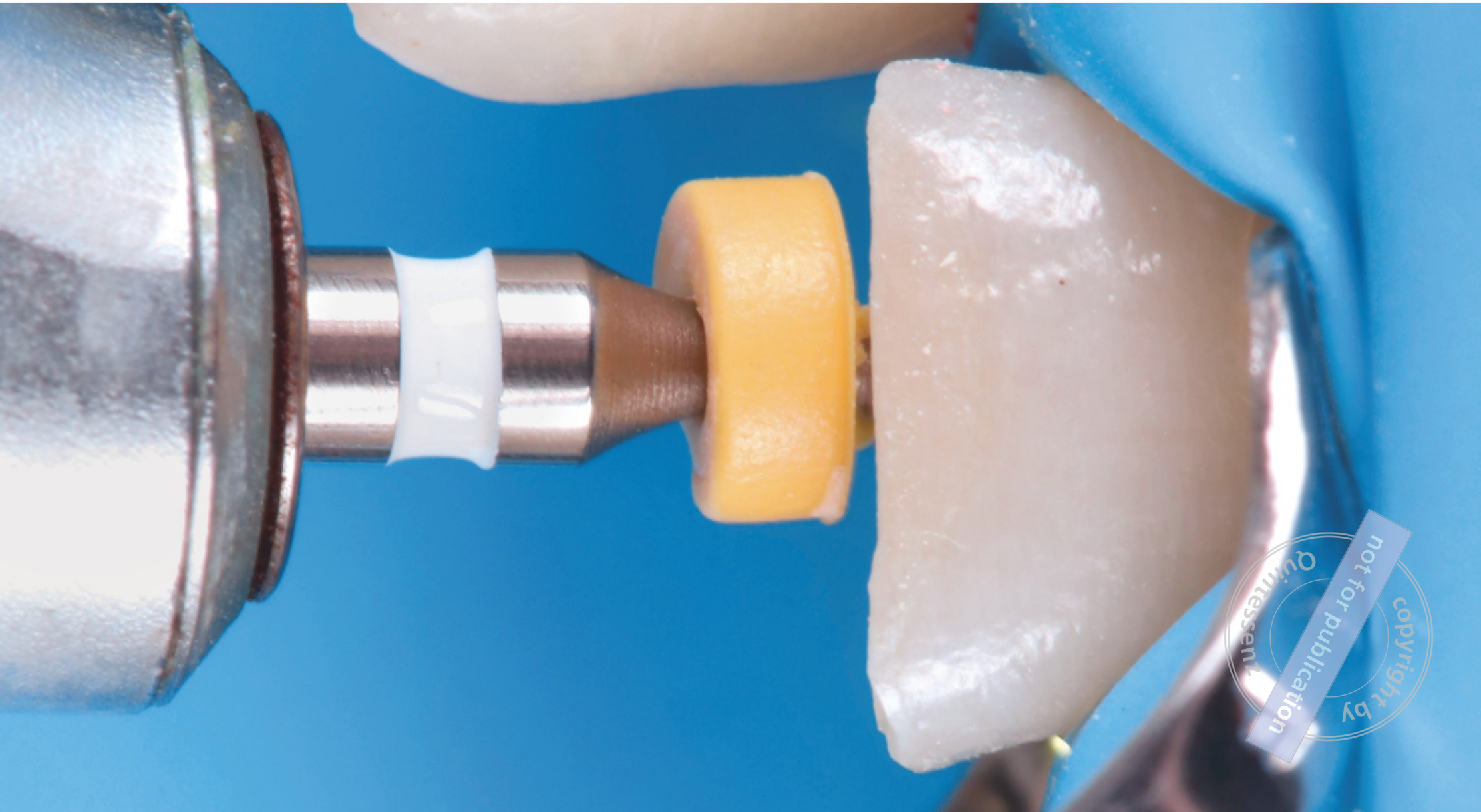
At the end of September, three months before Christmas, I received a gift (what a gift!), and I felt like a boy welcoming Santa Claus. This time he (Santa Claus) arrived earlier and came via a more modern means of transportation: a social network message. He had a name and an address, and I had known him for many years; since he was a dental student at the Pontifical Catholic University of Minas Gerais in Belo Horizonte, Brazil. The gift he offered me was much bigger and better than any I had received before (without detracting from any of the others): writing the presentation of his book... I mean, their book.

Rodrigo Albuquerque, whom I met as a student and over the years saw become an excellent dentist, teacher, and family man, took the role of Santa Claus and handed me the gift on behalf of all the authors. I must admit that when I received the gift — I mean, the invitation — I was moved and very happy. Extremely happy. Then I felt the weight of it (regardless of the number of pages), and because of that, I almost made the sacrilege of returning it without even opening it. Thank God I did not because when I finally opened it, I was amazed. The book has excellent content, is current, and well-written. Everything is scientifically based and without guesses, not to mention the excellent quality of the photographs, layout, and clinical cases, demonstrating the vast experience of the authors and editors.

After reflecting a little, I realized that the gift was not to write these words but to have received this excellent book. Therefore, as I am not ungrateful and much less selfish, I would like, from the bottom of my heart, to thank Rodrigo, Nelson, and Luís for the invitation. At the same time, I would like to congratulate them on their excellent work. Finally, I would like to share with you the gift — I mean, the book — they gave us. May you read it and enjoy all that is good in it. May everyone enjoy this gift and may it provide you with many others. A kiss to all and a Merry Christmas... I mean, a happy reading.

Luiz Narciso Baratieri

PRESENTATION



The idea to write a book about prefabricated posts was not sudden. On the contrary, as soon as I finished dental school, I got my certificate in operative dentistry at the Paulista Dental Association in Araraquara, São Paulo. There, Professor Ueide Fontana introduced me to prefabricated posts, which I had only read about up until then. After that, these devices started to have the utmost importance in my professional life, being the theme of my master's dissertation and PhD thesis, numerous publications in national and international journals, four book chapters, many courses, and other activities, with particular importance to the extension project "Restorations of Teeth with Dental Trauma", coordinated by me at the College of Dentistry of the Federal University of Minas Gerais. Thus, based on this long experience, I decided to invite to join me in this work my friends and fellow professors at the College of Dentistry of the Federal University of Minas Gerais, Nelson Silva and Luís Morgan — professionals who were a fundamental piece in this work because of their competence and care. This is a book that, I can corroborate, was written with all the dedication and care necessary to provide the reader with a rich and high-quality text.

The interest in further exploring this subject arose from the unsuccessful clinical cases repeatedly reported by colleagues in scientific meetings, even though this is a well-explored subject in the literature. Therefore, an almost commanding question (and a need) arose: why not establish a base protocol so that success could be achieved when using this type of restoration? Imbued with this idea, I got in touch with Quintessence/Napoleão Publishing, which accepted, with interest and willingness to publish, the proposal to write a book concerning this type of procedure, combining clinical practice with evidence and scientific-technological advancement.

I must confess that it was challenging to select the material for the book. We wanted a work that was not too long, that was didactic, and valued the text and its scientific content in addition to the impeccable images. Thus, the book was divided into ten chapters prepared in a didactic sequence that could make it easier for academics and dentists to apply these techniques in their day-to-day practice. Therefore, we have thought about producing content with a modern appeal, presenting some more sophisticated techniques, however understandable and executable. It is not the intention of the work to privilege elite dentistry but rather to bring elements which are accessible to all colleagues who work in the area.

I want to thank Luís and Nelson for having accepted the invitation to collaborate in the laborious work of this book; they were chosen not because of our solid and long-standing friendship but because they are profoundly knowledgeable about the subject from a scientific point of view and also from a vast clinical practice.

Finally, I would like to dedicate this book to the students and patients who, after all, are the main reason for our relentless pursuit of knowledge.

Rodrigo Albuquerque

ACKNOWLEDGEMENTS

First, I want to immensely thank Professor Luiz Narciso Baratieri not only for the preface on this book but for reminding me that he, along with Professor Marcílio Miranda, were my primary references and inexhaustible sources of inspiration in my career.

To the dean of the College of Dentistry at the Federal University of Minas Gerais, Henrique Pretti, and our chair at the Restorative Dentistry Department, Maria Elisa de Souza Silva.

To the company P-Oclusal, which kindly provided the dentoforms. To Grupo Slice and Vinicius Machado; to 3Shape, represented by Lars Christian Lund and Rune Fisher; to Compass 3D and Bruno Gribel; to Dr Francisco Gama; to Herbert Mendes, Fábio Krohn and Mônica Halfeld from Ivoclar Vivadent; to Antônio Carlos Vieira, Gabriella Zaidan, Emilene Santos and Janne Calixto from Ultradent; to Roberto Alcântara and Lygia Madi from Ângelus; Friedrich Mittelstädt, Bianca Mittelstädt, Mirna Padrão and Grazielle Dias from FGM; Carolina Miyazaki, Marcelo Ajej, Luana Nunes and Rôsi Felício from 3M ESPE; to Péricles Costa and Fabiana Nolasco from Dentsply Sirona; to Fernanda Hang and Cris Oliveira from Coltene; to Daniel Melo and Moacir Lacerda from SDI; Erick Lima and Mayara Ribeiro from GC; Oscar Laimer and Kátia Sumino from Voco; to the dental technician Telmo Santos from Coterc; to the dental technician Rafael Slywitch from VittaDent Atelier.

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SUMMARY

Rodrigo Albuquerque
Luís Fernando dos Santos Alves Morgan
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01 INTRODUCTION

The restoration of an endodontically treated tooth has challenged clinicians and researchers because, even today, it generates a series of doubts and discussions. There has yet to be a consensus regarding the ideal technique for restoring these teeth. Prefabricated intraradicular posts, intradentinal pins, or even metal cores, have often been indicated empirically and subjectively without complete knowledge of biomechanical or clinical principles that determine their correct indication and selection.[1]

Endodontic treatments have been increasingly promising, which has contributed significantly to increasing the longevity of pulpless teeth. Therefore, we must seek a restorative technique that is equally beneficial to restore these dental elements' function and esthetics to allow them a long life. What is sought is to avoid failures that have been common, such as root fractures, crown fractures, displacement of pins, and recurrence of caries, among other possible failures.

Restoring endodontically treated teeth is undoubtedly a complex procedure. Such difficulty can be perceived in the literature through the incessant search for scientific knowledge to elucidate hypotheses and guide clinical procedures. Participating in lectures or conferences in the most diverse scientific meetings is enough to learn how much this topic generates doubts for dentists. Questions about the procedures, techniques, and materials used are frequent. The current objective of related studies has sought to answer the classic question: What is the most suitable technique for restoring pulpless teeth? Unfortunately, this question cannot be answered precisely so far because doubts remain even in the face of continuous production of knowledge, mainly concerning the materials and techniques used.

Endodontically treated teeth are known to be fragile.[2] Dentin loss due to fractures, caries, non-caries lesions, and endodontic treatment decreases the mechanical resistance compared to pristine teeth. Therefore, preserving the healthy tooth structure as much as possible is part of the current paradigm of dentistry and should be sought in all treatments.

One of the main factors in restoring endodontically treated teeth is to guarantee retention for the future restoration. Based on this concept, in 1743 Fauchard advocated the insertion of a wooden pin inside the root canal to increase retention.[3] Since then, the evolution of these procedures has led to the development of several alternatives, such as cast metal cores and prefabricated posts, in addition to different types of materials and techniques for cementation.

A tooth affected by caries or fracture becomes fragile due to the extensive loss of dentin, cavity preparation, endodontic access, and root instrumentation.[4] The loss of strategic dental structures such as proximal surfaces in anterior teeth, marginal and oblique ridges in posterior teeth, and the roof of the pulp chamber reduce resistance as these losses add up.[5,6] For this reason, these restorations must involve careful planning, selection of materials and techniques, and restoration.

A possible factor causing the decrease in tooth resistance is the hypothesis that removing the dental pulp would reduce dentin hydration, resulting in changes in the dentin's resilience, making it more friable.[7,8] However, different studies show that a pulpless tooth's hydration loss is only 5–9%, barely influencing fracture and shear resistance.[2,9,10] Reeh also showed that the decrease in tooth resistance is more related to the loss of tooth structure, which is more significant as the number of surfaces lost increases, in agreement with the study by Franco in 1981.[10,5] Another possible cause contributing to the increase in the incidence of fractures in endodontically treated teeth is the loss of the proprioceptive mechanism and the increase in the pain tolerance threshold.[11,12] This condition could cause a lack of control of chewing forces on these teeth, leading to fracture.[13]

Considering these particularities, the most important thing is to be conservative in cavity preparation and preserve healthy tooth struc-

ture, bearing in mind that no restorative material replaces dental tissue.[14-16] Selecting the appropriate material and restorative technique is essential, focusing on restoring the tooth's functions.

Faced with countless doubts when we search the literature, attend the most diverse scientific events, and receive questions from clinicians, it is pertinent to write this book to display our philosophy and consider the current trends in restoring destroyed teeth, which may or may not require additional retention through conventional methods until we reach those that employ digital methodologies. All this is based on our clinical experience and scientific evidence.

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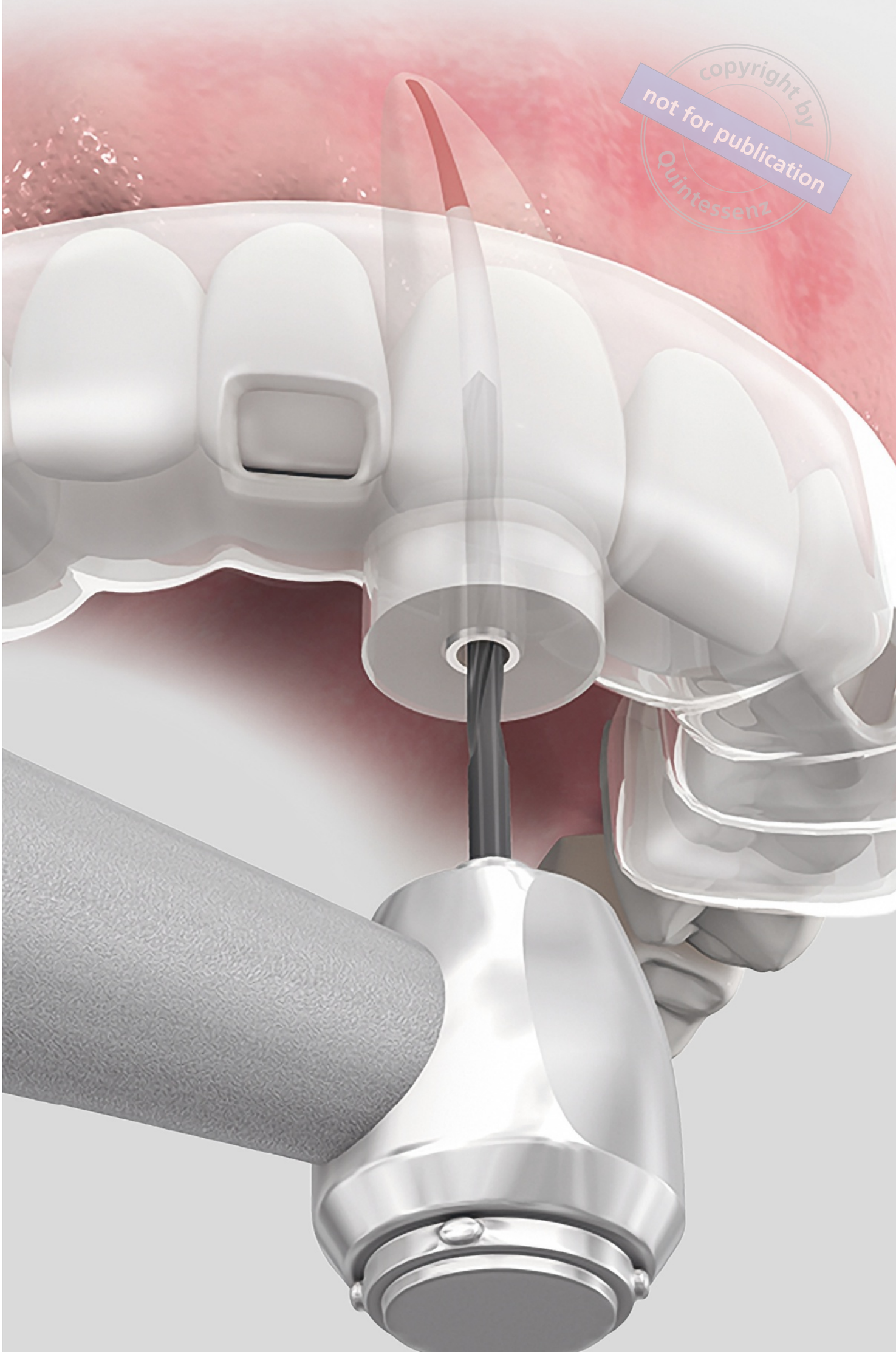

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02

REMOVAL OF INTRARADICULAR

POSTS

INTRODUCTION

The success of endodontic treatment requires chemical-mechanical disinfection of the root canal system associated with a hermetic filling and restoration to protect the tooth structure. Even with the success rate of endodontic therapy reaching a level of around 94%, we sometimes face cases that require endodontic retreatment due to deficiency in the initial treatment and periradicular pathology.[1] Most of the time, the dentist will come across endodontically treated teeth with extensive coronal destruction that have already undergone the restorative procedure and have intraradicular retainers.

To perform endodontic retreatment, it is necessary to remove these posts. At this moment, the challenge begins for both the general dentist and the specialist.

In the past, the most viable clinical alternative for endodontically treated teeth with intraradicular retainers which required retreatment was to perform endodontic surgeries. According to Torabinjad et al., the success of this procedure was 77.8%.[2] Currently, the success rate of endodontic retreatments can reach 86.8% when the anatomy of the root canal is maintained or restored.[3] However, even today, removing the intraradicular retainer is a particular challenge. If its removal is not carried out properly, it can lead to the dental element's extraction in the worst-case scenario.

The combination of fiber posts and composite resin cores has gained popularity recently due to its mechanical and esthetic properties. Fiber posts have an elastic modulus like dentin, drastically reducing the risk of root fracture compared to metal and ceramic ones due to the better stress distribution.

The inadequate conformation of intraradicular cores from the biomechanical point of view, as well as the presence of periapical lesions and unsatisfactory endodontic treatment, are frequent clinical situations requiring the removal of a post.

Among the problems related to removing intraradicular retainers, the following can be listed: excessive root wear, deviations, root perforations, and coronal or root fractures, among others.[4,5]

The removal of intraradicular retainers is directly related to their type (cast metal or prefabricated), the lower or higher modulus of elasticity of the alloy used in their manufacture, their configuration (smooth, serrated, threaded, parallel, conical), glass fiber adhesive posts, carbon or even quartz fibers, the type of cement, its length[6–8] and adaptation (poorly or well adapted concerning the thickness of the cement).[9,10] The following characteristics must also be observed: single or multi-rooted tooth; root anatomy (thin or thick); and the supporting canal.[11]

The ideal technique for removing intraradicular retainers requires minimal removal of tooth structure, with a low risk of fractures and perforations, and should be simple and quick to perform. Several techniques and devices have been suggested for removing retainers, including rotatory instruments, sonic or ultrasonic vibration, and traction, with increased effectiveness with magnification.

It is essential to point out that the professional must carry out a careful clinical-radiographic analysis of the dental element before starting the procedure. According to Ruddle, several factors influence the success of removals, such as the training and experience of the professional and the use of the best techniques and technologies.[12] In addition, dentists must know the anatomy of teeth and their variations.

Even today, the most used techniques to remove intraradicular posts are rotatory instruments,[13] mechanical traction using a pin punch,[14–16] and ultrasonic vibration.[17]

Due to the growing demand for cosmetic interventions in dental practice, new metal-free retention systems were developed, and with that we began to seek alternatives for their removal. Some systems have specific burs for removal; however, in most situations, the clinician faces posts of unknown origin, making it difficult to use the removal systems provided by manufacturers.[18]

The incorporation of clinical microscopy in dental offices, from the 1990s onwards, enabled greater precision in endodontic procedures. Removing intraradicular posts became more quickly and safely, minimizing accidents such as deviations, perforations, or root fractures. The glass fiber post is difficult to visualize and has a similar color to the dentin structure and the cement. The clinical microscope provides illumination and magnification, facilitating the visualization of the post and providing greater security to the removal process.

The need for safe ways to remove fiber posts has led to studies and the development of new techniques that facilitate the clinician's removal of these posts safely.

GLASS FIBER POST

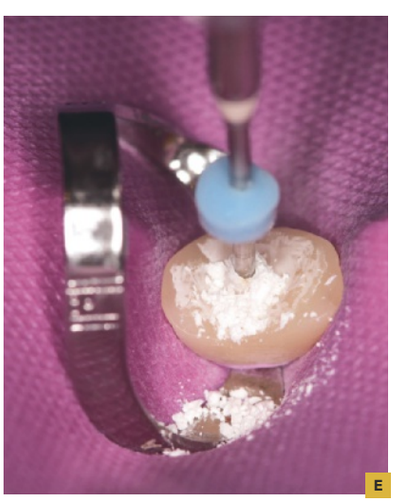
Glass fiber and carbon posts have recently become the posts of choice for replacing metal posts.[8] Their use is widespread because they optimize the use of the tooth structure for retaining the prosthetic crown.[12,20] The use of prefabricated posts has increased due to their esthetics and mechanical properties.[21] Its structure consists of fibers embedded in an epoxy matrix, where the elasticity is similar to dentin.[22] Its retention occurs through adhesive agents and makes removing these posts quite challenging.

Removal of adhesive posts is a complex procedure. It requires extreme care from the professional to avoid iatrogenesis, such as canal perforation, crack propagation, deviation from the path of the root canal, or even root fracture.[23,24]

Post retention can be influenced by the type and thickness of cement, the pre-treatment of the post, and the irrigant used to prepare the post space.[25,26]

REMOVAL OF GLASS FIBER POSTS WITH BURS

One of the most considerable difficulties encountered by the operator removing glass fiber posts is visualizing the material inside the conduct. Due to the tooth-like color, there is an excessive risk of dentine wear instead of the post. Low-speed burs associated with magnification and microscope illumination allow optimal control (Figures 01A-G) compared to high-speed, mainly in posts positioned up to the apical third of the root.

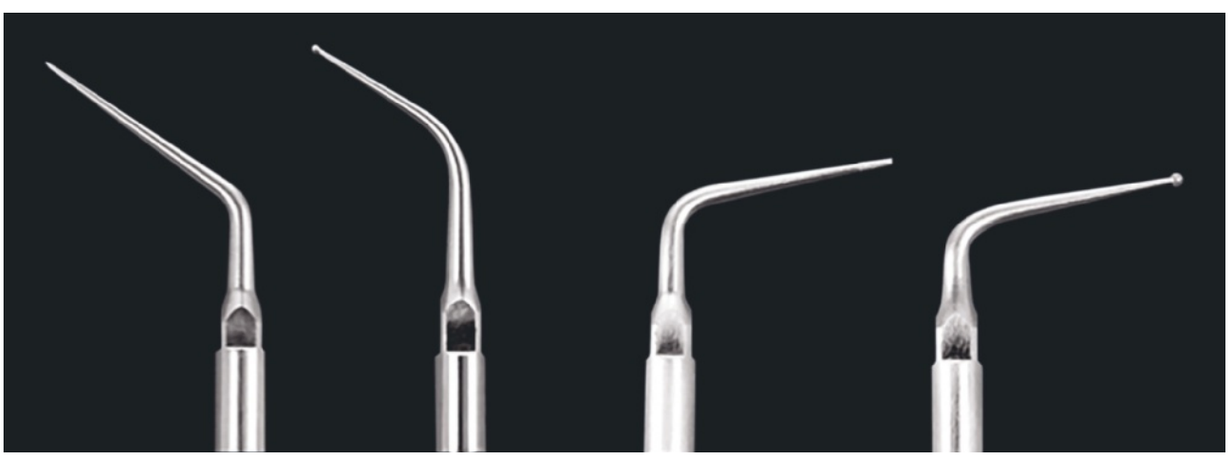


01A-G · Munce Discovery bur (CLM Engineering) **(A)**. Removal of glass fiber post using Munce Discovery bur (CLM Engineering) **(B-G)**.

REMOVAL OF GLASS FIBER POSTS WITH ULTRASOUND

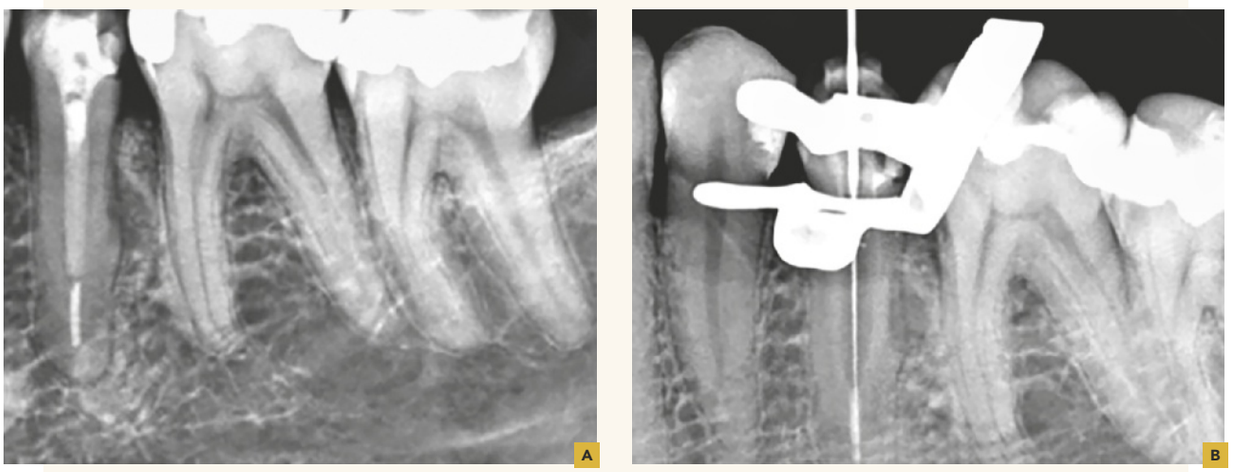
In the case of glass fiber posts, the ultrasound technique can also be used with the appropriate tips associated and the aid of magnification. The ultrasonic tips will wear down the post in the direction of the root canal. However, the heat generated during the ultrasonic procedure can be problematic, and the recommendation is to alternate ultrasound with water. At first, the operator starts the procedure using ultrasound without water for a few seconds and then incorporates the water outlet at the tip. This alternating use of water serves to clean the debris and cool the cavity and the tip, thus avoiding excessive heating of the tooth structure.

The smooth or diamond-coated ultrasound tips can be used in these cases (Figure 02). Notably, the choice of the tip will depend on the diameter of the post to be removed. Using smooth tips will break down the fibers through their vibration, breaking down the glass fiber structure. These tips have the advantage of visualizing the fibers using magnification and the possibility of distinguishing them from the dentinal tissue, improving safety and reducing the risk of perforation. Diamond-coated tips will cause a more accentuated wear of the post. If, on the one hand, the removal will be quick, on the other hand, the operator may lose the reference of the post for a moment. It is helpful to remember that removing the pin using this technique requires patience and calm on the part of the operator, who should wear the material only after ensuring that it is in the correct trajectory of the post. The smooth and diamond-coated tips must be positioned on the post, not touching the dentin walls (Figures 03A-H and 04A,B).



02 · Helse Dental Technology ultrasonic tips.

03A-H · Glass fiber post removal using ultrasonic tips.



04A,B · Radiographic appearance after glass fiber post removal using ultrasonic tips.

REMOVAL OF CARBON FIBER POSTS WITH ULTRASOUND

The removal of carbon fiber posts using ultrasound should be performed similarly to the removal of glass fiber posts. A singularity of carbon fiber posts lies in the fact that, during their wear, debris will form on the dentin walls due to the release of carbon. Thus, the clinician must thoroughly clean the canal using the ultrasonic tip to avoid losing the post reference.

Some authors used micro-CT to evaluate the tooth wear caused by removing glass fiber posts using diamond-coated ultrasound tips cooled with water compared to special removal kits. They suggested that ultrasound tips also increase microcracks aside from wearing down more tooth structure. Despite an increase in these cracks, according to the authors, there was no statistically significant difference in the method compared with removal kits. It was also observed that neither method effectively removed the posts from the canals. These authors concluded that removing the posts with the removal kits was faster and preserved more dentin structure than the ultrasound method. Additionally, they suggested that using ultrasound tips for fiber post removal may compromise the root, decreasing its resistance to fractures.[24,27,28]

USE OF THE CONE BEAM TECHNIQUE (CBCT) AND CAD/CAM TECHNOLOGY FOR THE REMOVAL OF FIBER POSTS

Currently, there are few studies comparing the effectiveness of various methods for removing glass fiber posts.

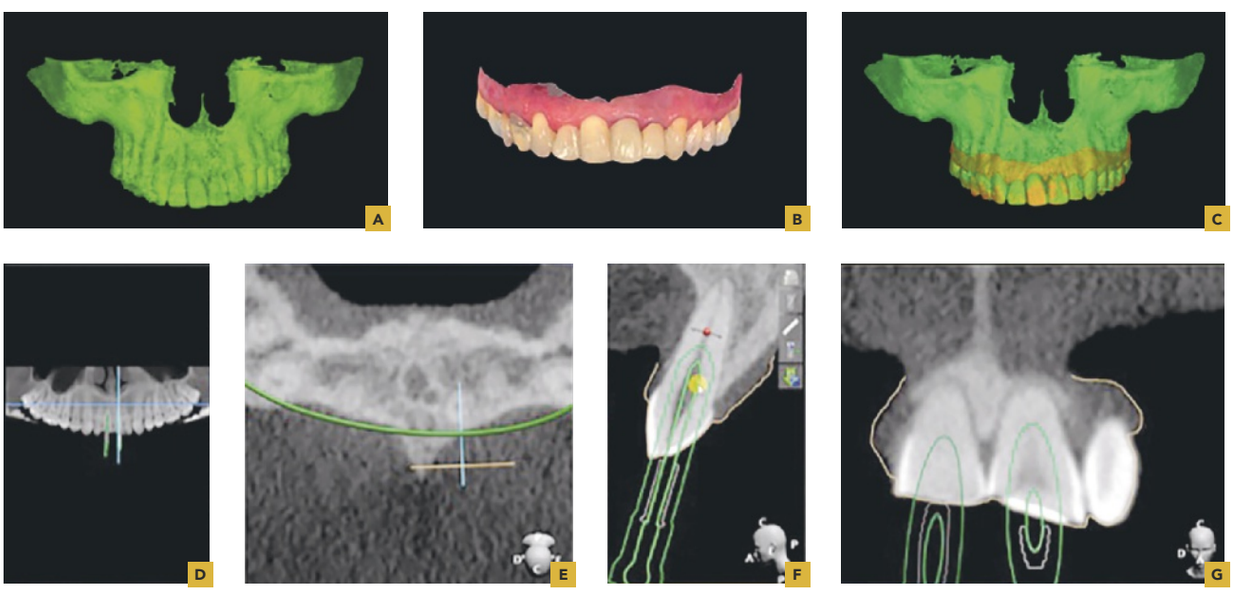
One recently developed technique in dentistry, called "guided endodontics", combines Cone Beam Computed Tomography (CBCT) and surface scanning (CAD/CAM) to create a prototype guide for negotiating partially or fully calcified canals using minimally invasive burs. This guide can safely assist in removing adhesive posts by directing a bur with the appropriate diameter through the root canal, thus preserving the root structure.

Brazilian researchers have created a prototype guide that is easy to use and standardized, even for professionals with little to no experience. This approach helps avoid and minimize excessive root wear, crack propagation, root path deviation, and perforations, while also enabling the removal of all post material located within the root canal.

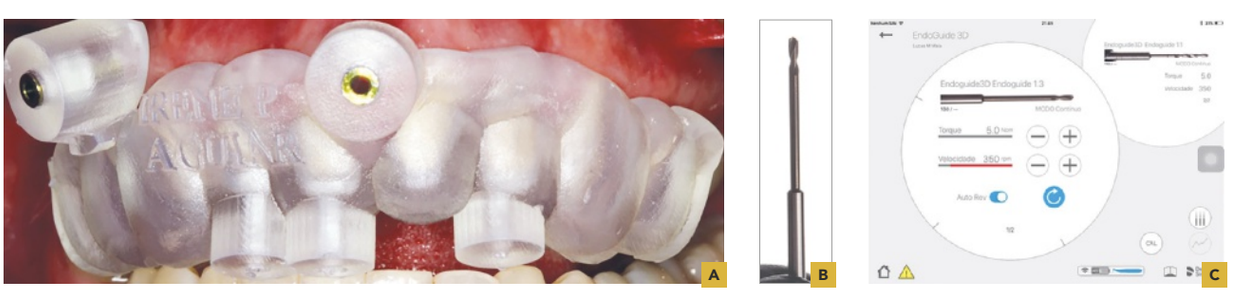
Preventing cracks or fractures while preparing post spaces or removing a post is essential and must be considered when choosing the treatment method.[27]

Through the prototyped guides, CAD/CAM technology allows for a technique that can be used to remove glass and carbon fiber posts. The combination of intraoral scanning and a prototyped endodontic guide to perform the removal of these posts offers safety, speed, preservation of root structure, and agility in endodontic treatment, avoiding and reducing excessive root wear, propagation of cracks, deviation of the root path, perforation, as well as cleaning of debris inside the root canal (Figures 05A-C to 08A-G).

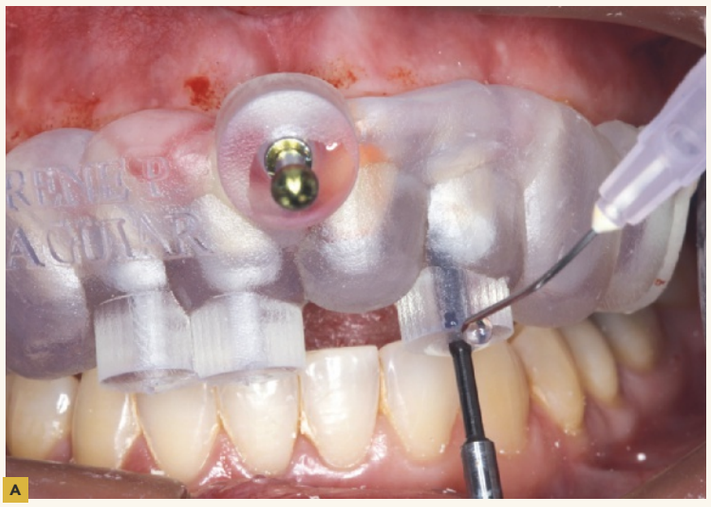
05A-C · Case of unsatisfactory endodontic treatments on teeth 11, 12, and 22. Note the presence of adhesive root retainers **(A)**. Initial clinical appearance and after removal of temporary crowns **(B,C)**.



06A-G · Virtual planning.



07A-C · Guide adaptation test **(A)**. The bur used (Neodent Drill for Tempimplants, Ref: 103179; JJGC Ind e Comércio de Materials Dentários SA, Curitiba, Brazil) coupled to the X-SMART IQ electric motor (Dentsply Maillefer) **(B,C)**.



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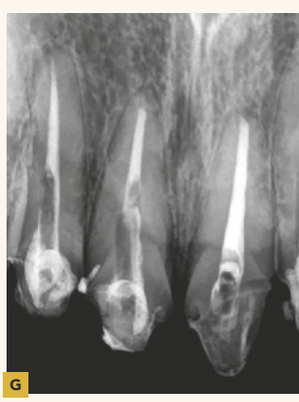

G

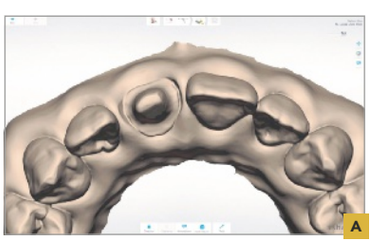
08A-G · Clinical sequence **(A-F)**. Final radiograph after removal **(G)**.

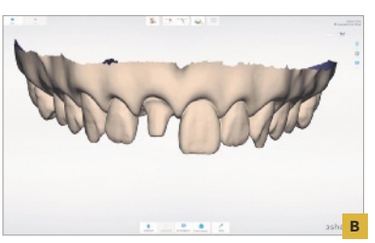
DIDACTIC SEQUENCE OF REMOVAL OF GLASS FIBER POST ON A DENTOFORM

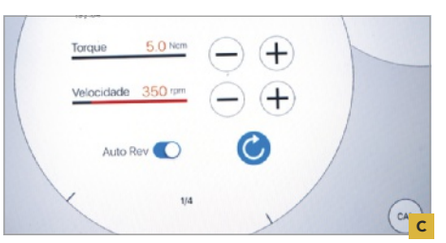
09 · Front view of the dentoform with a cemented glass fiber post in tooth 11.

10 · Incisal view of the dentoform with a cemented glass pin in the region of tooth 1.1.

11A,B · Acquisition of images by scanning frontal view (Scanner 3Shape) **(A)**. Acquisition of images by scanning frontal view (Scanner 3Shape) **(B)**.





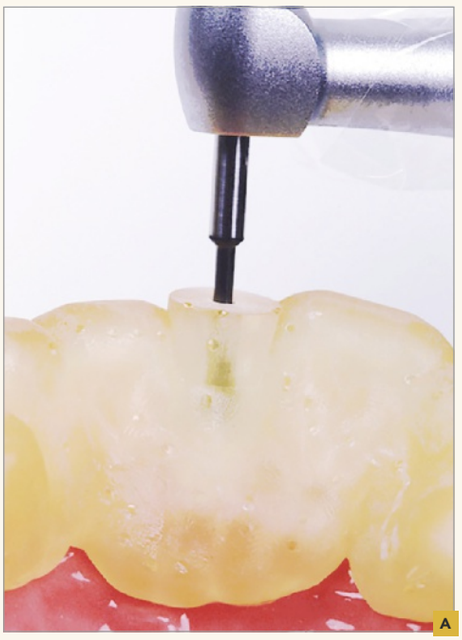


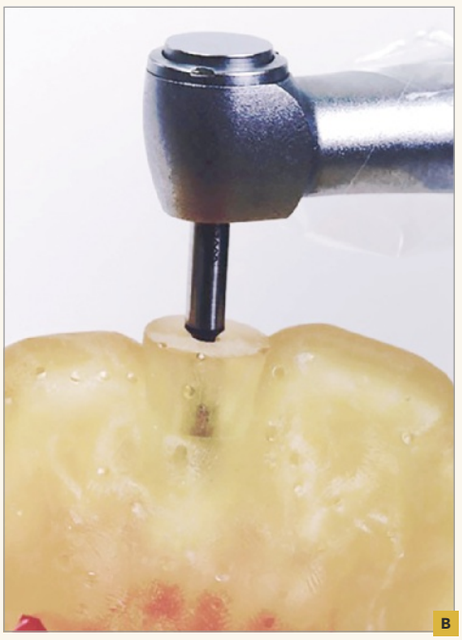
12A-C · Acquisition of images by scanning incisal view (Scanner 3Shape) **(A)**. Image acquisition by scanning incisal view (Scanner 3Shape) **(B)**. Torque and speed programmed for the use of the bur. Bur used to remove the fiber post (Neodent Drill for Tempimplants, Ref: 103179; JJGC Ind e Comercio de Materials Dentários SA, Curitiba, Brazil) coupled to the electric motor X-SMART IQ (Dentsply Maillefer) **(C)**.

13A,B · Glass fiber post seen from the incisal view **(A)**; Guide positioning incisal view **(B)**.

14 · Front view of the guide in place.

15A,B · Guide for orienting the bur to remove a glass fiber post **(A)**. Positioning of the bur (Neodent Drill for Temp-implants, Ref: 103179; JJGC Ind e Comercio de Materiales Dentários SA, Curitiba, Brazil) **(B)**.





16A,B · Penetration of the bur through the guide removing the fiber post **(A)**. The bur reaches the programmed end point on the guide for removing the apical part of the fiber post **(B)**.

17A,B · Frontal view of the programmed bur stop point **(A)**. Finishing removing the fiber post and removing the guide **(B)**.

CLINICAL SEQUENCE FOR GUIDED TECHNIQUE

- After the clinical examination, a periapical radiograph was obtained to evaluate the existing endodontic treatment to confirm the need for fiber removal and non-surgical endodontic retreatment (Figure 18A).

- Two diagnostic models were generated from the 3D data obtained by CBCT and oral cavity scanning (TRIOS Color Pod; 3Shape A/S) (Figures 18B,C).

- These conversions were exported to virtual planning software (SimPlant 15.0 Pro; Materialize) for CBCT-based planning (Figure 19).

- The diameter of the bur was determined according to the length and diameter of the post. A virtual guide was created using design software, and the model was exported as an STL file (Standard Mosaic Language) (Figures 20A,B); then, it was sent to a 3D printer to produce the prototype guide (Figures 21A,B).

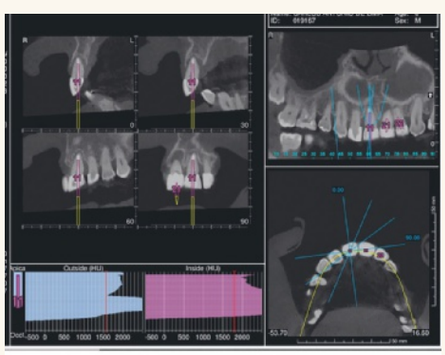
- The adaptation of the guide was verified (Figure 22).

- The bur was selected and advanced in the path traced by directing the guide until the adhesive post was removed entirely (Figures 23A-F).

We observed that post removal techniques adapt as the materials and techniques used to manufacture intraradicular posts evolve. With the increasing use of glass fiber esthetic adhesive posts, more specific methods, such as CBCT and guided endodontics, facilitate their removal. We must be aware that techniques will continue to evolve ever-increasingly, and we must be attentive to new methodologies and techniques. Removing adhesive posts through a guided technique with CAD/CAM planning (Figures 24A-D) is a safe way to be used by less or more experienced clinicians, thus becoming a promising option for removing adhesive posts.


A


B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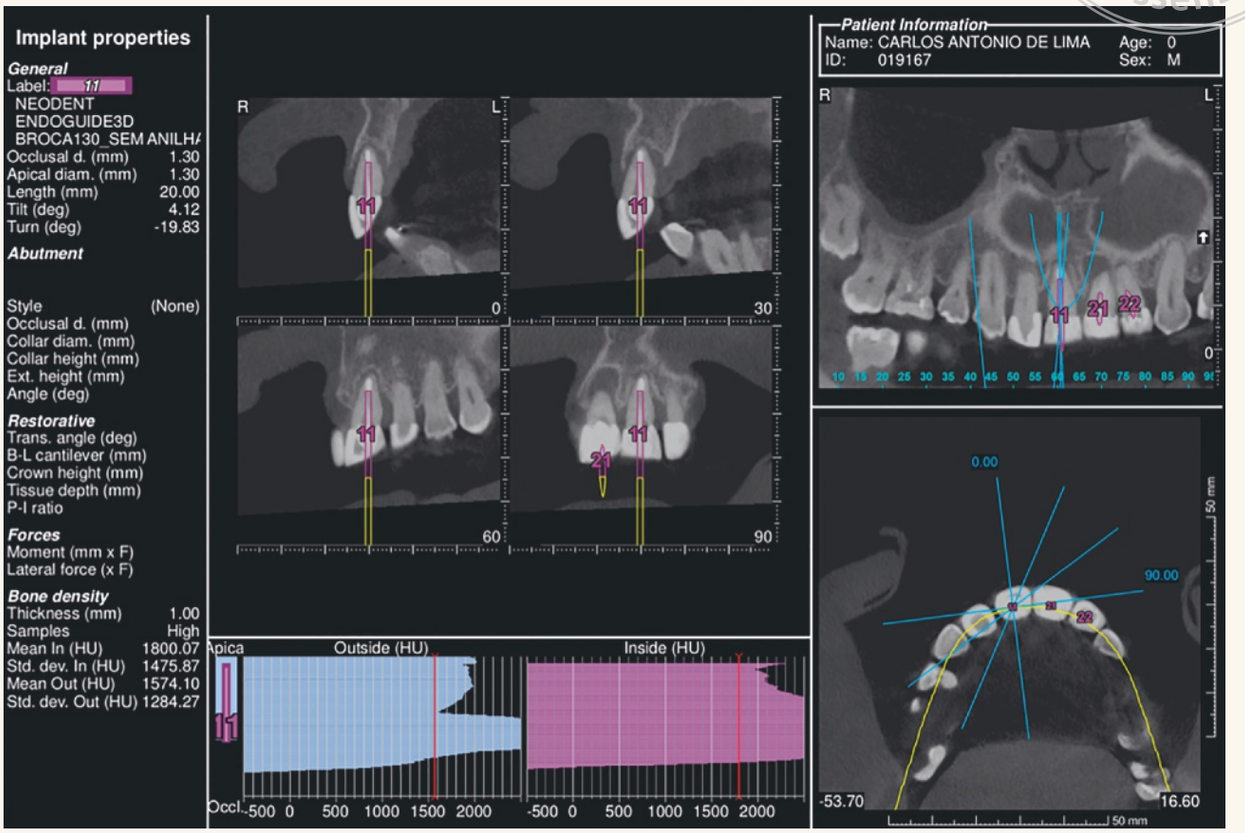
18A-C



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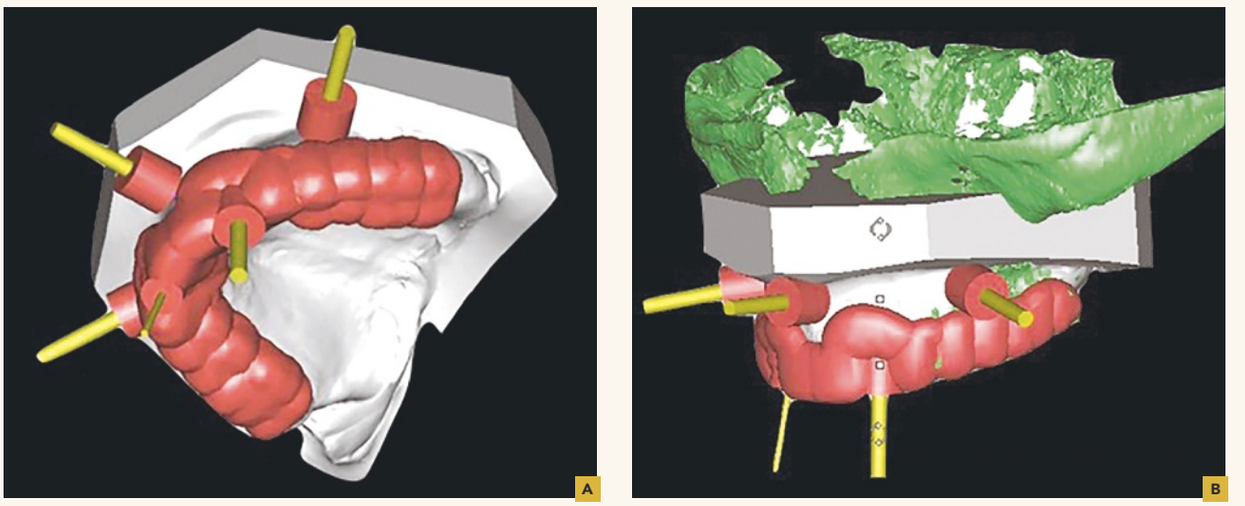
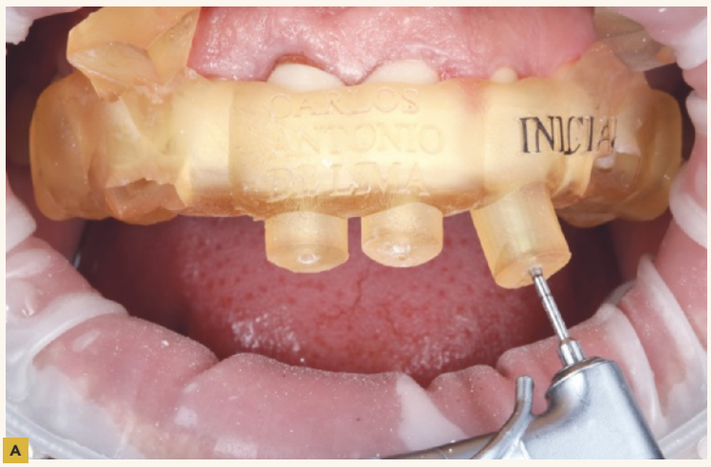


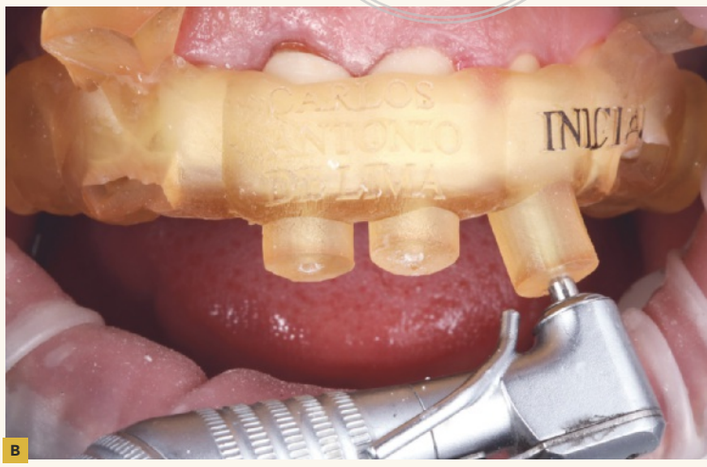
20A,B

21A,B

22



A



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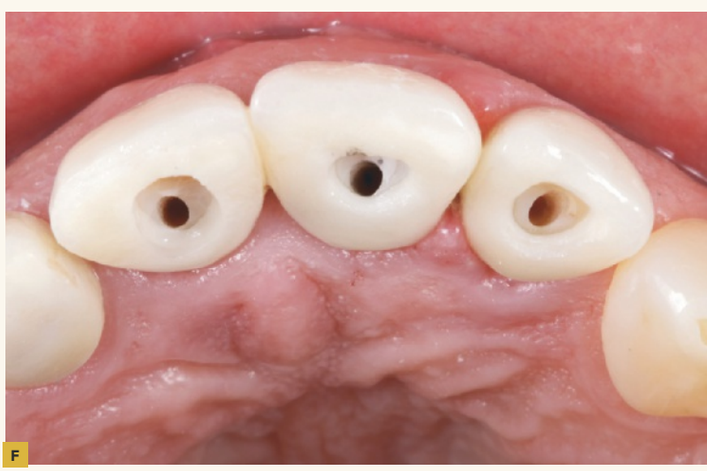
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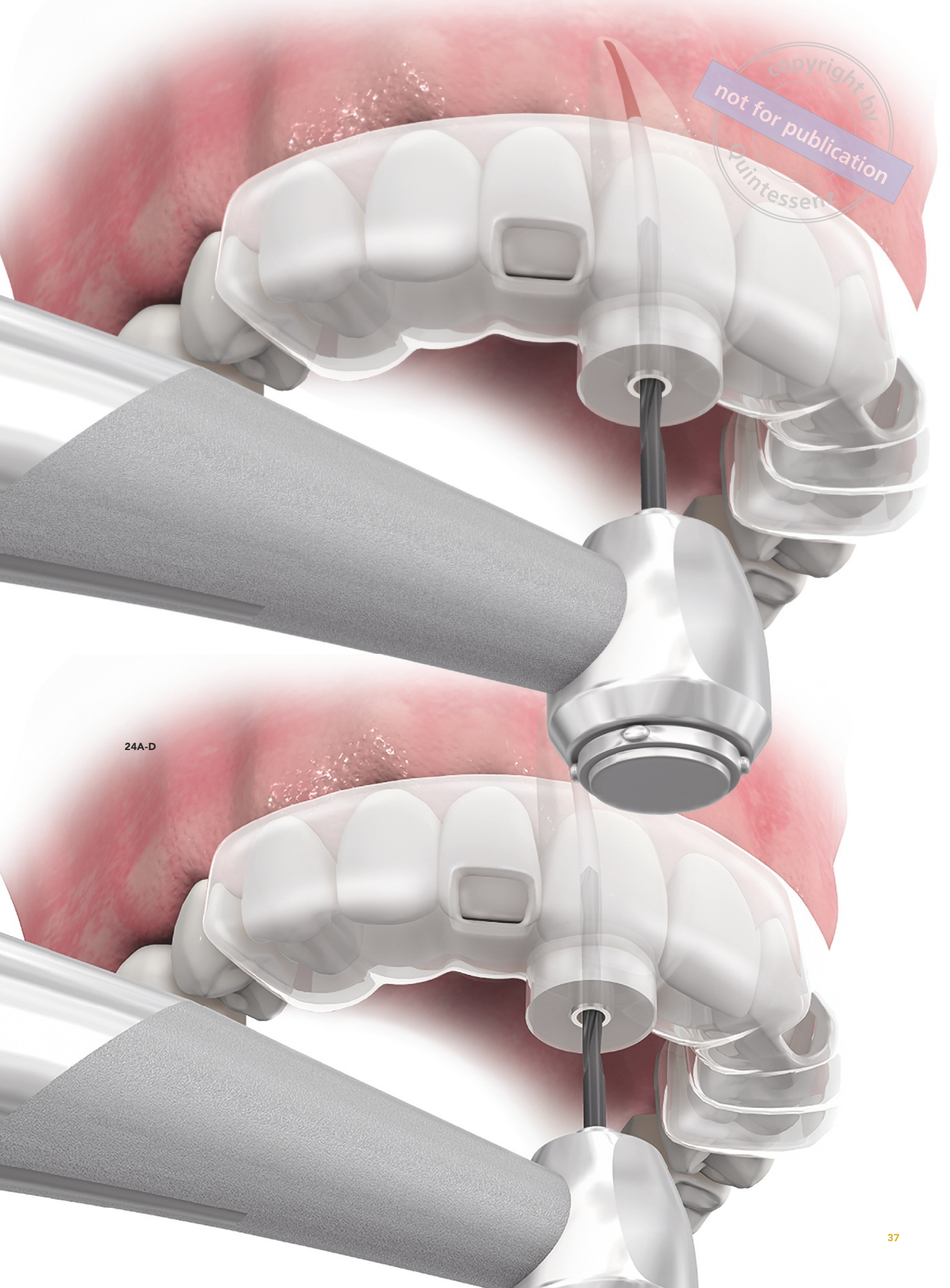
23A-F



24A-D

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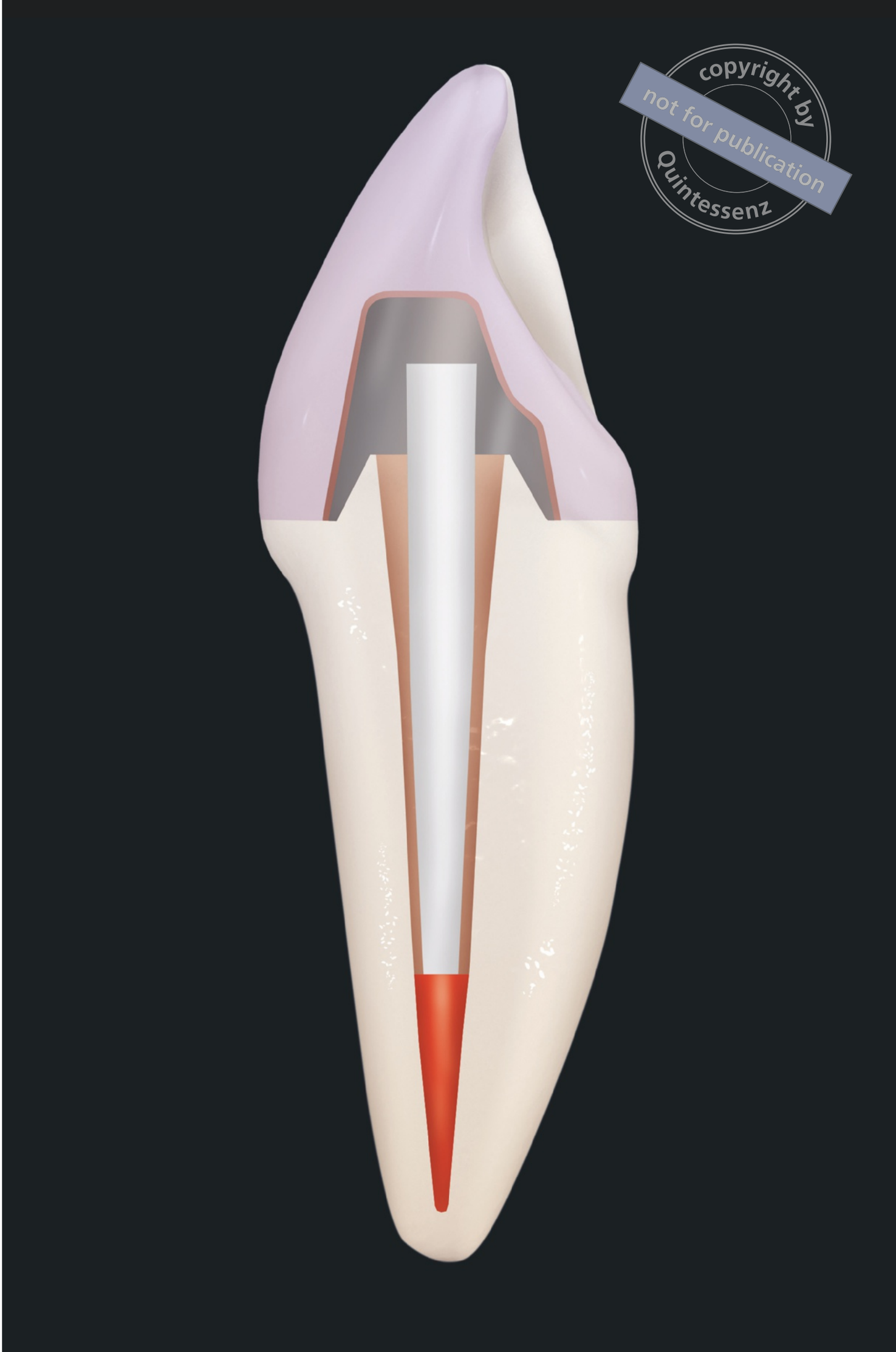

Restoring endodontically treated teeth is undoubtedly a complex procedure. A sound knowledge of biomechanical and clinical principles, careful planning, and the selection of appropriate materials and restorative techniques is essential to achieve the best functional and esthetic outcomes. This concise and exquisitely illustrated book, based on the philosophy and clinical experience of its authors and on sound scientific evidence, is divided into 10 chapters in a didactic sequence to make it easier for dentists to apply the techniques in everyday practice. The focus is on preserving the heathy tooth structure as much as possible using both conventional and digital methodologies.

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