Implant Prosthodontics:
Protocols and Techniques for Fixed Implant Restorations

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IMPLANT PROSTHODONTICS

Protocols and Techniques for Fixed Implant Restorations

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Contents

Whenever you see this symbol throughout the book, it indicates that a downloadable version of the checklist is available via QR code. All of the checklists are also printed in the appendix.

Foreword

Implant dentistry has become a major part of modern clinical practice. Clinicians, whether in private practice or in academia, must be familiar with the surgical and prosthetic aspects of this highly specialized area of dentistry. This textbook will provide the clinician, from the novice to the experienced implant dentist, with both classical and modern evolving prosthetic principles and techniques that will help you with everyday implant dentistry.

The "fixed implant restoration" is what most implant patients demand and expect. To provide the implant patient with long-term clinical success with this type of prosthesis, the clinician must take an interdisciplinary approach beginning with treatment planning and continue this multispecialty approach through to the delivery of the definitive prosthesis and beyond. There are many clinical pearls in this textbook that clinicians will find valuable in their everyday clinical practice of implant dentistry.

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Clinical Professor, Oral & Maxillofacial Surgery
University of California, Los Angeles School of Dentistry

Preface

It is my intention that this book serves you as a key resource in the clinical practice of restoring implants in partially edentulous patients with fixed restorations. I have designed the text to provide the essentials of implant prosthodontic workflows and protocols based on the best available current evidence. In it you will find concise guidelines and checklists for every aspect of restoring dental implants. Many of the techniques also feature a QR code linking you to a video demonstration of the procedure. I have included directions and photographic demonstrations with three of the major implant manufacturers: Nobel Biocare, Straumann, and BioHorizons. Additionally, each section features an explanation of some special considerations related to the technique.

It is my sincere hope that this book will serve you well in guiding you through the complex world of implant prosthodontics in a way that is easy to reference at each stage of the procedure. The checklists for each technique are included in the appendix for easy use intraoperatively by printing or loading onto a tablet. Use the QR code to access them electronically, or simply photocopy them from the appendix.

> "Some of us have great runways already built for us… But if you don't have one, realize it is your responsibility to grab a shovel and build one for yourself and for those who will follow after you."
>
> – *A. Earhart*

Acknowledgments

First and foremost, I thank my amazing wife, Amy, for her continuous support and encouragement. Thank you to my dad for always being a source of inspiration personally and professionally. Thank you to my clinical teammates, Dr Peter Moy and Sam Alawie (Beverly Hills Dental Lab) for their hard work, expert care, and collaboration on the cases in this text. Thank you to John VanDyck at Nobel Biocare, Steve Boggan at BioHorizons, and Adam Dorsky formerly at Straumann NA for their loan of equipment and components for this project. And thank you to Leah Huffman, Bryn Grisham, Sue Zubek, and Sarah Minor at Quintessence for their exceptional guidance, artistry, and expertise in bringing this project to life.

Special thanks to Dr David Wagner for his contribution of chapter 2 and for his stylistic guidance on the project as a whole. Thank you to Dr Faris Khalifa for his expertise in reviewing and editing the manuscript. Thank you to Dr Joan Pi-Anfruns and Dr Perry Klokkevold for their skill and collaboration on respective cases in chapter 5. Thanks to Dr Daniel Balaze for the stripped screw image and to Dr Marc Hayashi for the broken abutment image in chapter 7. And thank you to Dr Kiyotaka Shibahara for the custom Kanji calligraphy on page ix.

Thanks to my many colleagues around the world for their support, particularly Drs Kent Knoernschild, Chandur Wadhwani, Luigi Canullo, Xavi Vela, Xavi Rodriguez, Istvan Urban, Henry Takei, Tom Han, Chris Barrett, Young Kim, Jae Jang, Ed Swift, Erik-Jan Muts, Bill Yancey, Hazem Torki, Richard Stevenson, Paul Child, Justin Moody, Scott Keith, Bach Le, Hooman Zerenkelk, Homa Zadeh, Dwayne Karateew, Sonia Leziy, Brahm Miller, Nader Salib, Ed McLaren, Reuben Kim, Panos Papaspyridakos, Joseph Kan, Jean Wu, Gary Solnit, Mark Exler, Tota Shimizu, Tara Aghaloo, Yuki Minami, Senichi Suzuki, Dan Cullum, Michael Block, Alireza Moshaverinia, Tomas Linkevicius, Alessandro Pozzi, Steve Sadowski, Harald Heymann, Thomas Dodson, Amir Aalam, Alina Krivitsky, Darryl Burke, David Guichet, Barry Levin, Ernesto Lee, Michael Whang, Ryan Tse, Frank Higginbottom, Jeff Brucia, Gordon Christensen, Jacinthe Paquette, Steve Snow, Baldwin Marchack, Pat Allen, Cary Goldstein, Damon Adams, Sotirios Tetradis, Eddie Hewlett, Mathew Kattadiyil, Craig Misch, Ming-Che Wu, Mo Kang, Phil Melnick, and Bob Margeas as well as Dean Larry Wolinsky, Dean Paul Krebsbach, Dean No-He Park, and Dean Carol Lefebvre.

And finally, my eternal gratitude to my students—present, past, and future. I have learned so much from you. You inspire me to try harder every day. I love watching you progress and advance. I expect great things from you … Don't let me down!

How to Use This Text

This book is designed to guide you through the protocols and techniques for restoring dental implants. It is recommended that you start with the introductory chapter. This will ensure that you are on the right track and ready for the details provided in all subsequent chapters. The structure is designed so that you will be able to look up any specific procedure you intend to perform and have a concise guide on how to properly execute it. Each chapter provides guidance on selecting an appropriate protocol or restoration, explains the rationale for the given procedure, and provides a detailed step-by-step protocol followed by special considerations and potential complications. To the extent possible, all recommendations within are based on the preponderance of best available scientific evidence. Each chapter concludes with a few references for recommended additional reading should you wish to delve deeper into the rationale and science on a given topic.

Throughout the text, there are QR codes as seen here. Scan it with your phone or tablet camera for a video showing the technique for that chapter.

In the appendix at the end of the book are all the checklists for each procedure. These checklists are designed to be printed or digitally displayed in the operatory at the time of the procedure to ensure that each step is performed properly. It is my hope that you find this a useful addition to your clinical workflow.

初心不可忘

shoshin wasuru beka razu

Always remember the "beginner's mind"—an attitude of openness, eagerness, and lack of preconceptions when studying a subject, even when studying at an advanced level, just as a beginner would.

01 Principles of Dental Implant Prosthetics

Anatomy of Implant Prosthetics

Preprosthetic

Implant

The implant itself is the titanium "screw" inserted into the bone. Nearly all modern implants have a threaded design that is screwed into a hole (the osteotomy) created by a series of specially shaped drills. The size and shape of the osteotomy is specific to the implant that will be placed into it. Nearly all implants in current use follow a similar design with an internal connection whereby an abutment or restoration can be inserted into the connection space and held fast with an abutment screw.

Single-stage and two-stage surgical protocols

The two-stage protocol begins with placement of the implant and attachment of a cover screw to its platform, after which the implant is buried, or sutured, under the soft tissues. It requires a stage-two procedure at the completion of osseointegration for uncovering, where the cover screw is replaced with a healing abutment or provisional restoration.

In the single-stage protocol, on the other hand, the implant is placed, a healing abutment or provisional restoration is attached to the platform, and the soft tissues are sutured around this component. The healing abutment or provisional restoration is left in place until the completion of osseointegration prior to definitive restoration.

Cover screw

The cover screw is a small, one-piece, threaded cover for the prosthetic portion of an implant. It is placed at the time of surgery and prevents soft tissue ingrowth into the prosthetic connection area of the implant. It is used in two-stage surgical protocols, where the implant is buried under the soft tissue for the osseintegration phase. It is removed during stage-two surgery to allow placement of a healing abutment or provisional restoration.

Healing abutment

The healing abutment is a small component usually placed by the surgeon at the time of surgery or at the completion of osseointegration. It is used in a single-stage surgical protocol, where the implant is not buried but rather the soft tissues are allowed to heal around the healing abutment. The role of the healing abutment is to maintain access to the prosthetic platform after osseintegration, whereby it can be removed and allow access to the implant connection area. Healing abutments are generally cylindrical and made of titanium, although there are variations. Most restorative implant procedures start with the removal of the healing abutment.

Prosthetic platform

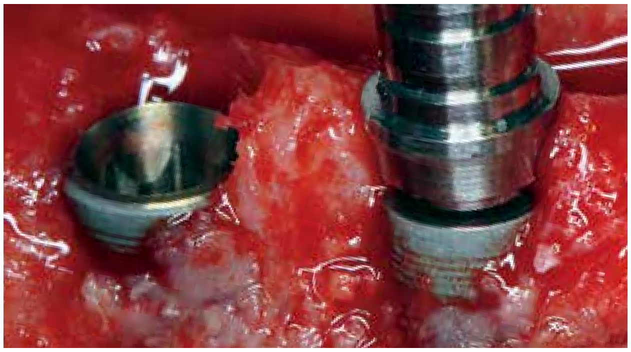
The platform is the area at the head of the implant where the abutment meets the implant. Platform sizes vary between manufacturers. They may be denoted by a measurement, a few letters, a color, or some combination of these. As the clinician restoring the implant, it is critical that you determine the exact manufacturer, system, and platform size of the implant you are restoring. Do not confuse the platform size with the implant diameter—they are rarely the same, and some systems offer various platform sizes within an identical implant diameter.

Connection

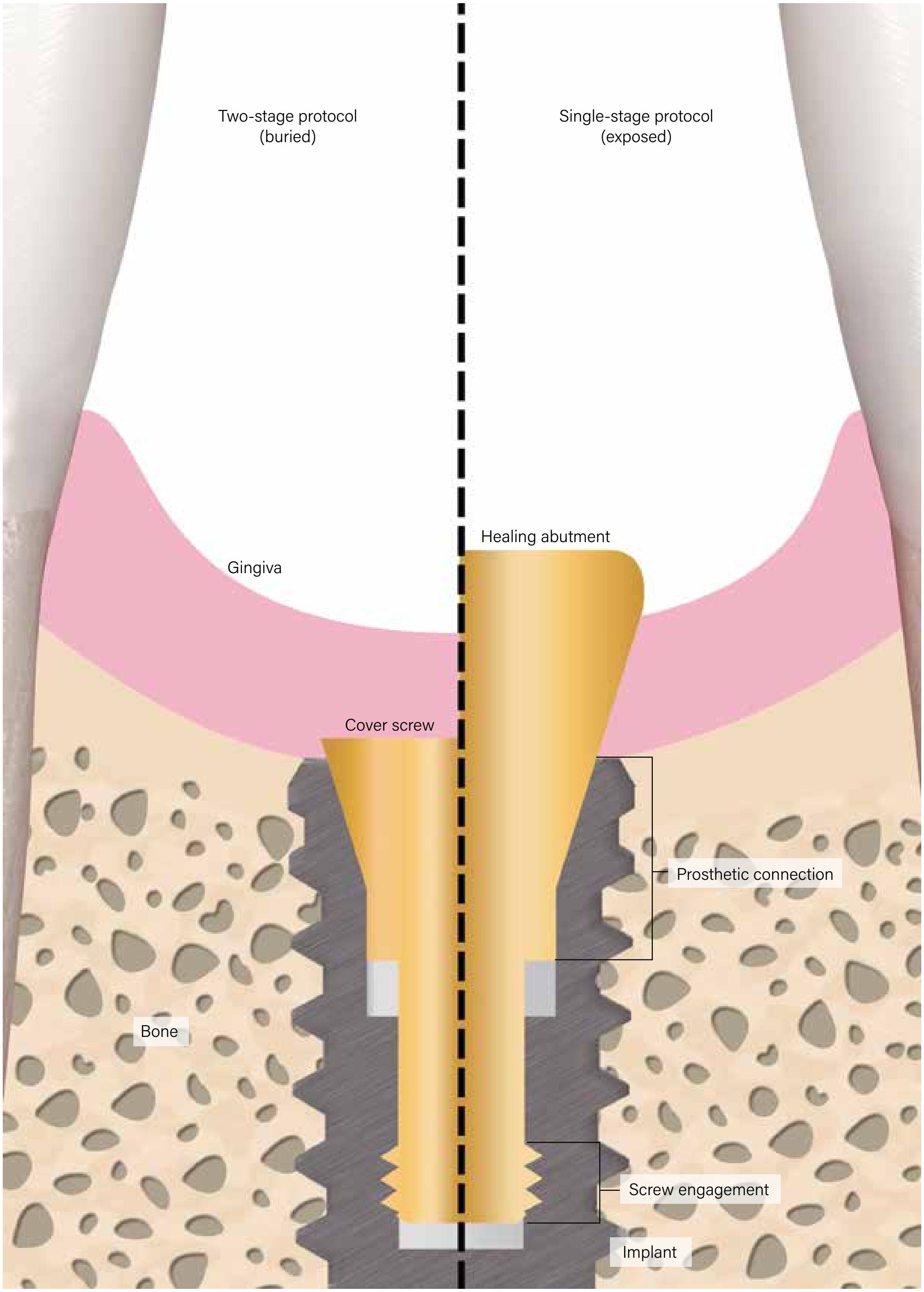
The connection area of modern implants is almost universally internal. It can take many different shapes: hex, octagon, spline, star, lobed, etc. Its role is to allow the abutment/restoration to engage the implant without allowing rotation. This is critical for single-unit implants. For prostheses splinting together multiple implants, it is largely unnecessary. In such designs, the connection is commonly bypassed. The connection also serves to enhance the integrity of the junction between the implant and the prosthetic components.

Screw engagement

Apical to the connection area inside the implant, there is a cylindrical, threaded area that allows various components to be firmly attached to the implant. The threads of this area are specific to the implant brand, type, and size. Screws are not universal or interchangeable.



Preprosthetic



Impression stage

Impression coping (or impression post)

The impression coping is the component that is attached to the implant at the time of impression. Its role is to transfer the exact implant position (x, y, z axes; tilt; and rotation) to the laboratory model. They are specific to the platform of the individual implant. They come in a wide variety of shapes, sizes, designs, and usage. Commonly they fall within three classes: open tray, closed tray, and digital scan body.

The "open tray" type is designed to stay embedded within the impression. Historically, this was also known as a "pickup impression," though this term has become ambiguous and fallen out of common usage. It has large retentive features and a long pin (or post), which allows it to be detached from the implant after the impression has set. It is so called because the impression tray must be modified to have an opening whereby the pin will pass through as the tray is seated.

The "closed tray" type is designed to slip out of the impression after it sets. Historically, this was also known as a "transfer type impression." It remains attached to the implant during the impression procedure and is only removed after removing the impression. It has a tapered design with no strong retentive features, and it does not require modification of the impression tray.

Digital scan bodies come in various designs and retentive mechanisms. They are attached to the implant at the time of the intraoral scan (digital impression) to transfer the specifics of the implant position, manufacturer, connection type, and platform size to the laboratory for fabrication of the restoration.

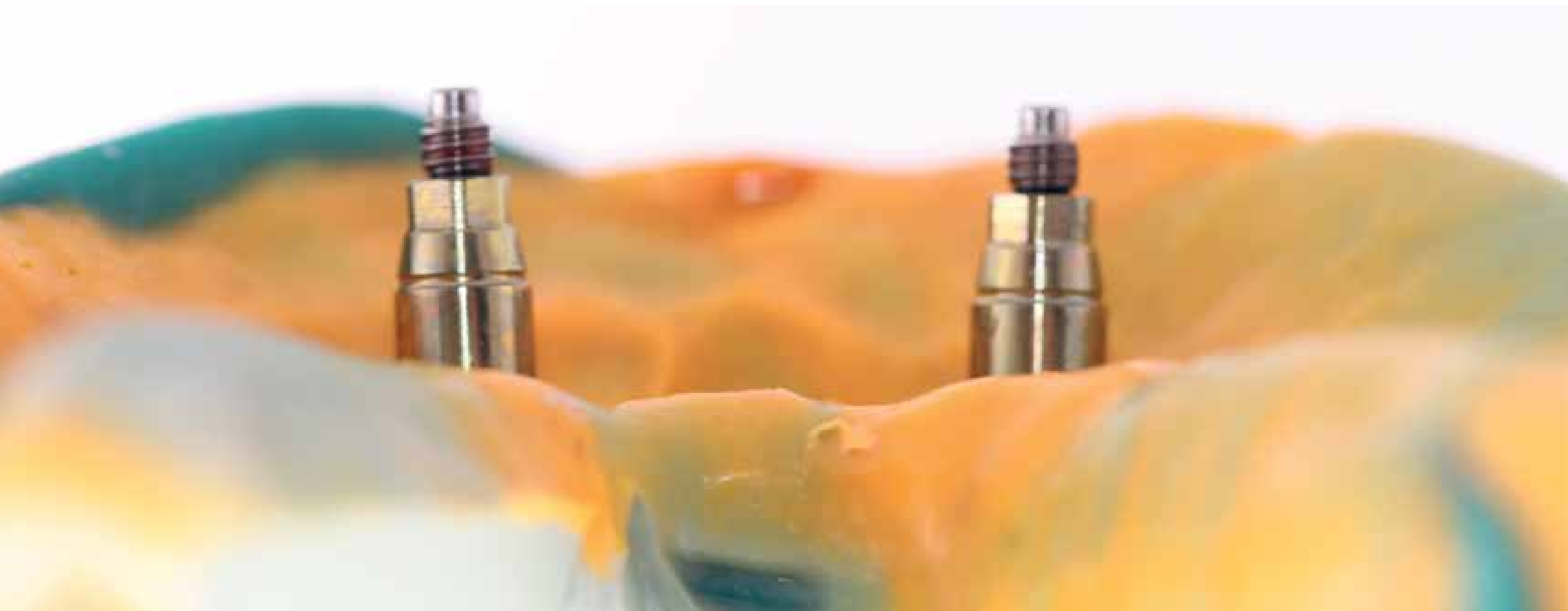
There are a few other types of impression (or scanning) copings, which are discussed in chapter 4.

Seating

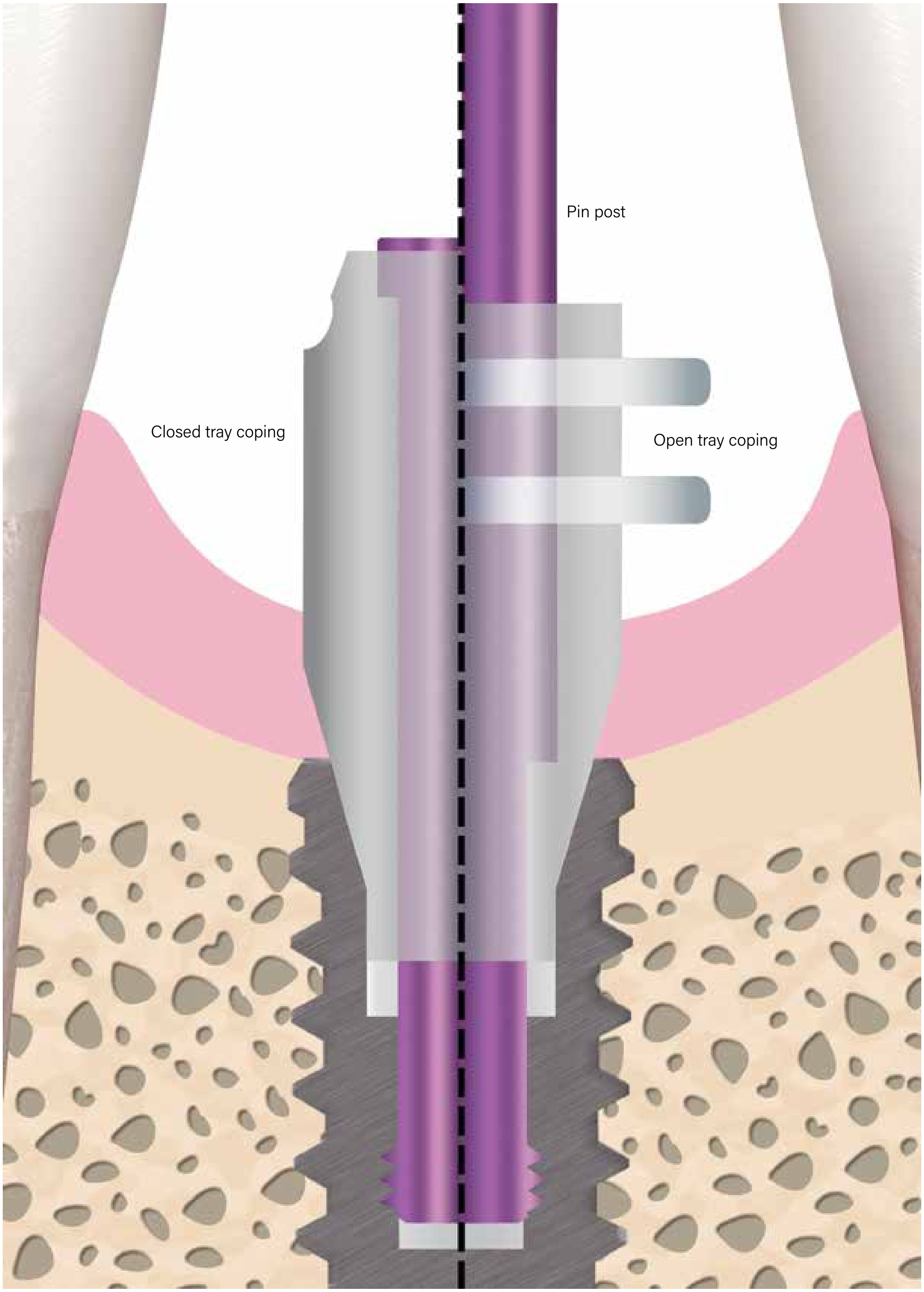
In implant prosthetics, the term *seating* refers to the connection between the abutment/fixed dental prosthesis (FDP) and the implant.

Splinted

When two or more implants are adjacent to each other, they can be restored as individual crowns or together as a single prosthesis. If they are connected together, this is referred to as a "splinted" design. It is analogous to a bridge and may or may not include a pontic. The decision to splint or not splint the adjacent implant restorations depends on many factors: implant connection design, bone volume, bone density, implant length, implant platform diameter, functional loads, esthetics, patient preferences, hygiene, etc. There are advantages and disadvantages to splinting, which are clarified in chapter 5. Impression copings can also be splinted together at the impression stage. The rationale and technique are explained in chapter 5.



Impression stage



Restoration stage

Prosthesis (or FDP or crown or bridge)

A crown or a bridge in implant restorations is properly referred to as a *fixed dental prosthesis* (FDP). It is the supragingival portion of the implant restoration. In most scenarios, it simply resembles the missing tooth or teeth, though larger restorations or those used in areas with severe bony or gingival defects may also have artificial gingiva as part of their design, as seen below. They can be retained by various means, though most commonly they are screw-retained or cement-retained.

The screw-retained FDP in its early design was a cast gold alloy framework with feldspathic porcelain (commonly called a *UCLA abutment*). More recent design developments include a hybrid (or "screwmentable") design whereby the FDP is fabricated with a screw access hole and cemented to an abutment in the laboratory. Thus, it is a cemented design that is screw-retained. There are various (and evolving) methods for fabrication and material selection. Common materials for implant restorations and abutments include titanium, zirconia, porcelain fused to metal (PFM), lithium disilicate, and combinations of two or more.

Abutment

The abutment is a component that attaches to the implant (almost always with an abutment screw) and allows a crown or bridge (FDP) to be attached to it. In some restoration designs, the abutment and crown (or bridge) are one piece and the entire assembly is retained with the abutment screw. In other scenarios, the abutment is designed to have the prosthesis cemented to it, either in the laboratory or intraorally. Common materials for abutments are titanium, zirconia, and cast metal alloys.

Abutment screw

In implant prosthetics, the term *screw* commonly refers to the screw that goes inside the abutment and fixates it to the implant. Most screws are torqued to 30–35 Ncm, though not all. They are very specific to the implant system being used, the platform size, and the restoration type. Under no circumstances should a clinician or technician assume interchangeability between screws.

Screw channel

The screw channel is a hollow portion in the abutment or prosthesis that allows the screw to be placed inside and allows the driver to reach the screw.

Preload

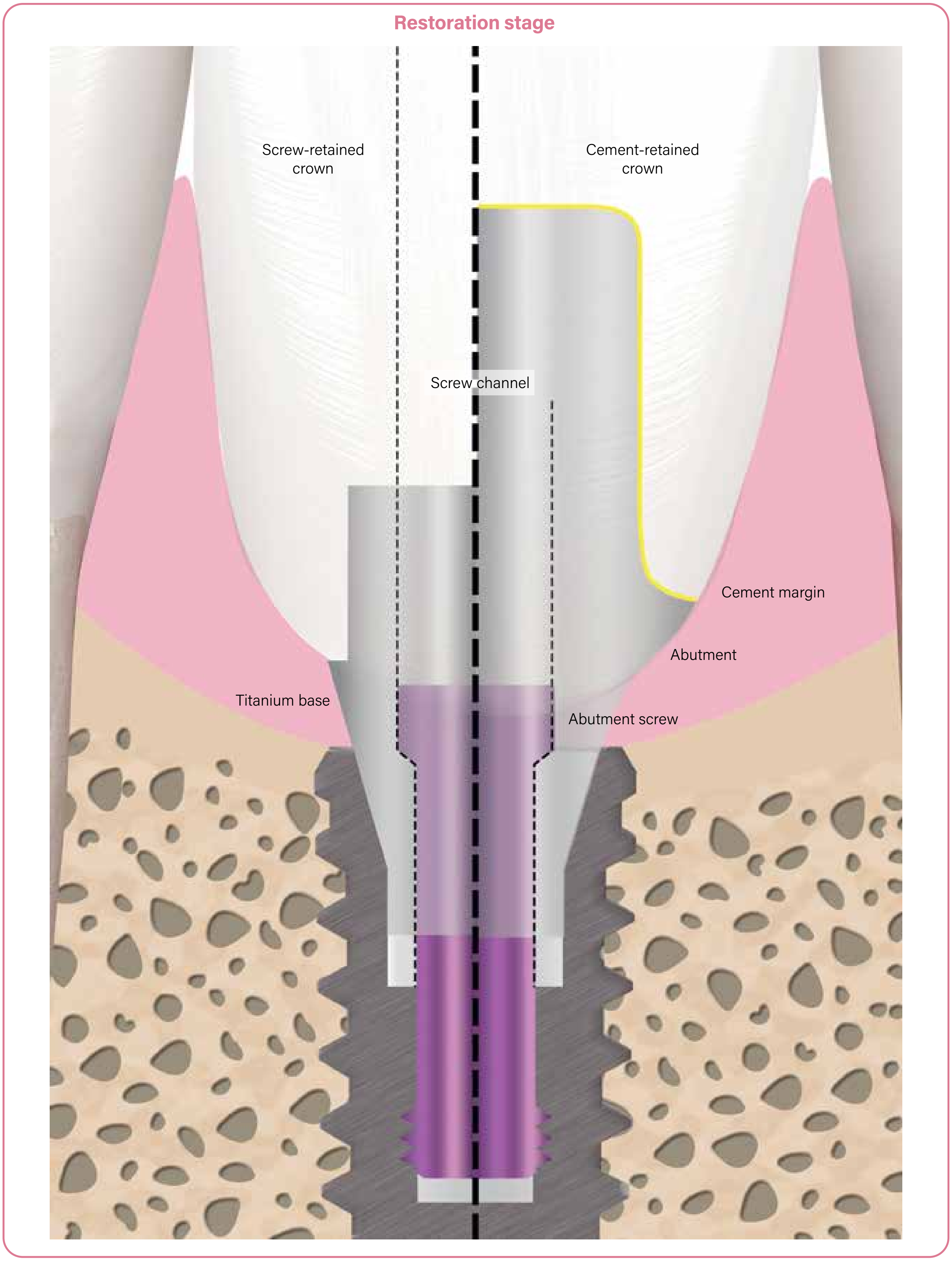
The abutment screw's role is to keep the abutment/FDP firmly attached to the implant. As the screw is torqued to its final tightness, it actually stretches. At the specified torque value, the stretch in the screw acts like a stretched spring, thereby establishing a tensile force that keeps the abutment "pulled" into the implant. This stretch or force is called *preload*. Development of the proper preload is imperative to creating the best possible connection between the implant and the abutment.

Torque

In implant prosthetics, torque is the rotational force applied to a screw. The correct torque must be applied to anything screwed into the implant (healing abutment, impression coping, definitive abutment) to ensure proper seating, minimize screw loosening, and stay within the physical limitations of the materials/designs.

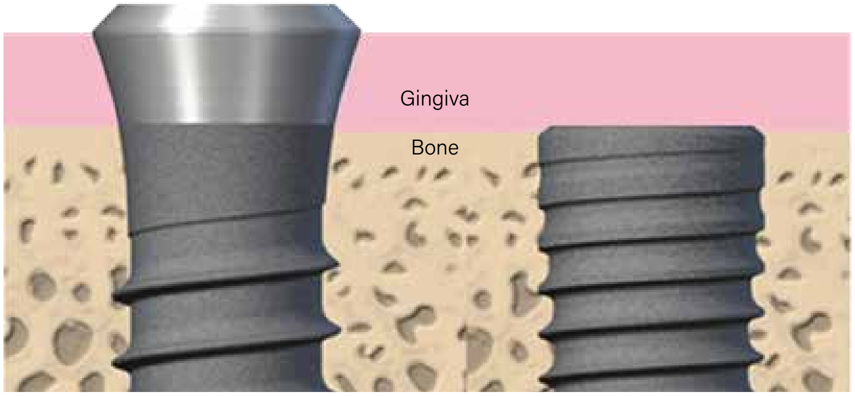
Driver

The driver is the small screwdriver-like device that fits precisely into the screw and allows the user to tighten or loosen it. In implant prosthetics, there are numerous driver types/sizes, and the clinician must be very conscientious of using the exactly correct driver. Use of an incorrect driver will damage or strip the screw head, both of which are relatively complicated problems to resolve. Manufacturers offer drivers in various lengths. The appropriate driver for a given scenario must be long enough to engage the screw, while not being too long to prevent its use due to interference from the opposing arch. Most drivers can be used by hand for general tightening/loosening of screws and then fitted into the torque wrench for final tightening. However, there are some drivers that only work by hand, and others that only work in a torque wrench.


Restoration stage
Screw-retained crown
Cement-retained crown
Screw channel
Cement margin
Abutment
Titanium base
Abutment screw

Implant specifics

Implants come in various shapes, sizes and designs. Most modern implants are threaded, and the prosthetic components are held in position by an abutment screw. The facing page shows implants and analogs from various manufacturers. The analog is a laboratory component that will be embedded in the cast from which the prosthesis will be fabricated. Its internal design is identical to the implant in the mouth. Most manufacturers color-code their components to identify the specific implant design and platform size. They are not interchangeable.



Note that each manufacturer uses a specific nomenclature to identify the implant system and platform size. For example, Nobel uses NP, RP, and WP to denote narrow platform (pink), regular platform (yellow), and wide platform (blue), respectively. The "cc" is used to denote their conical connection system. BioHorizons uses measurements to denote the specific platform size: 3.5mm (yellow), 4.5mm (green), and 5.7mm (blue). These measurements of the platform size are not to be confused or used interchangeably with the implant diameter. Straumann's bone-level implants identify the platform size as NC for narrow Crossfit (yellow) and RC for regular Crossfit (purple). The Straumann tissue-level implants use RN for regular neck and WN for wide neck.

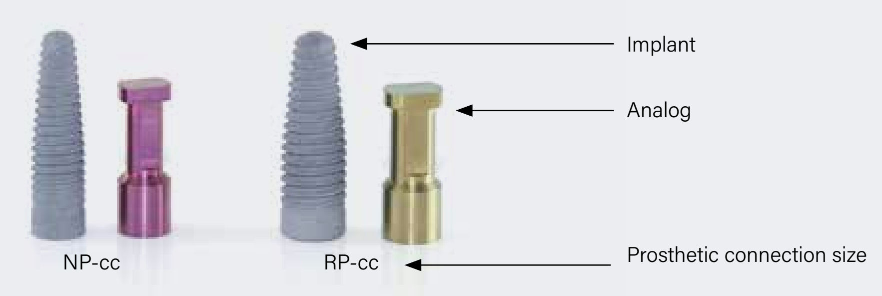
Most currently available implants are of the **bone-level** design, where the head of the implant is designed to be placed at or slightly below the crest of bone. This is a bit of an oversimplification as the bony crest is rarely completely flat mesiodistally and buccopalatally. Alternatively, a few manufacturers also offer a **tissue-level** implant design where the neck of the implant is designed to be placed in close approximation to the gingival margin. This is also the position at which the prosthesis will join the implant. The tissue-level implant keeps the prosthetic margin away from the bone crest, but it does not allow the restoring clinician to alter the margin position or emergence contour.

Implant diameter is not platform size

In some implant systems, each implant diameter has only one matching platform size. However, it is increasingly common for various implant diameters to have the same platform size. Below is an example from BioHorizons where the implant body diameters vary but share a platform size as identified by the color. As such, it is imperative that the restoring clinician know not just the implant dimensions but also the specific platform size of the implant to be restored.

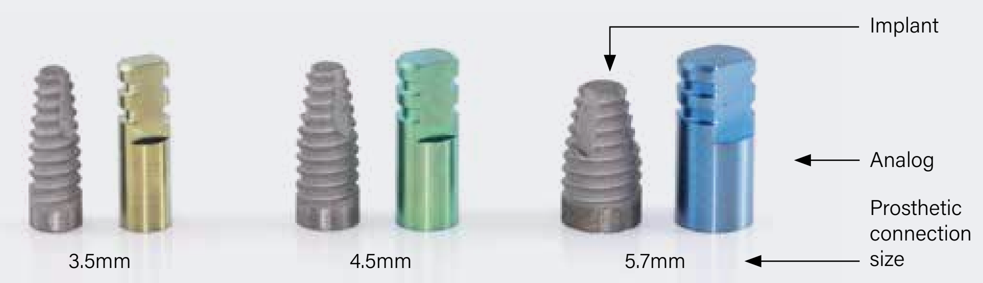
Types of implant sizes

Nobel Conical Connection



Nobel Tri-Lobe Connection

BioHorizons Bone Level



Straumann Bone Level

Straumann Tissue Level

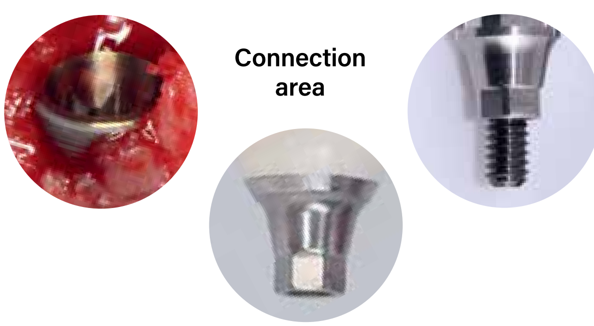
Implant connections

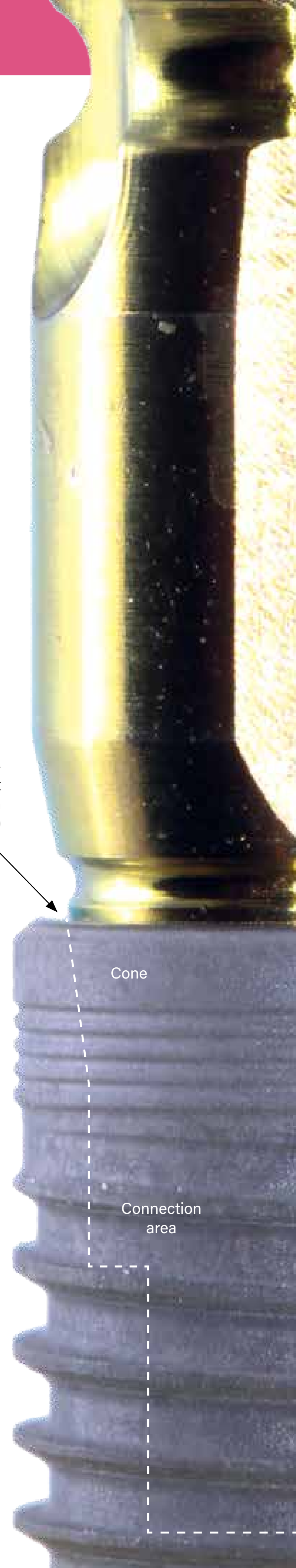
The connection area (ie, hex, trilobe) is a critical design feature of the implant. Its primary role is to prevent rotational motion of the abutment or prosthesis. It accomplishes this through the use of some geometric internal feature. As seen on the facing and following pages, manufacturers employ various shapes to achieve this goal.

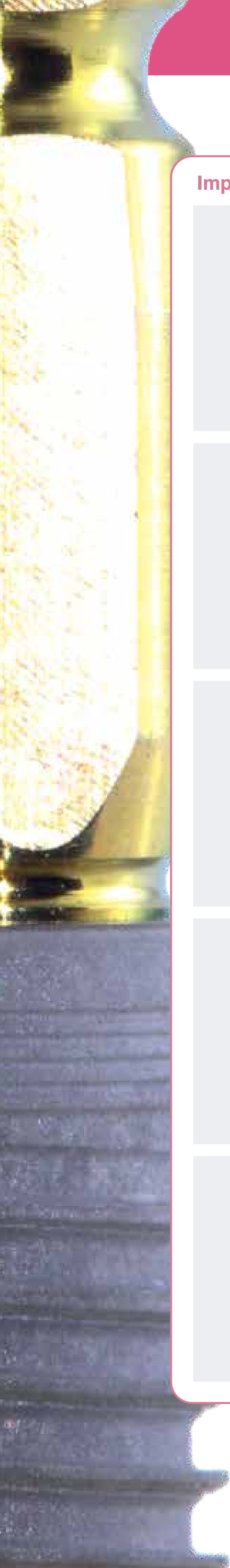
This connection also serves to enhance the stability of the connection between the abutment and the implant at the critical area known as the *implant-abutment junction* (IAJ). It is this junction that serves to prevent or minimize leakage of oral flora into and out of the internal aspects of the implant. The connection accomplishes this goal by providing rotational and oblique resistance to movement of the abutment inside the implant due to the cyclic forces placed on the system during regular use. Without this connection area, all such forces must be resisted by the small abutment screw alone. Due to the repeated heavy forces in the oral environment, the abutment screw can become fatigued without the mechanical support of the connection area. This was a fairly common complication with older implant designs and screw materials.

When tightened to the specified torque value, the abutment screw is slightly stretched and acts like a stretched spring that pulls the abutment into the implant and keeps it seated under tension. As mentioned earlier, this engineering principle is called *preload*. The seal between the abutment and the implant at the IAJ is critical to maintaining integrity of the restoration and the health of the peri-implant bone and soft tissue. This seal forms at the IAJ.

Most modern implants use some sort of cone design at the IAJ in an effort to enhance the seal. Although commonly referred to as a "Morse" taper, very few manufacturers utilize the specific criteria of the Morse taper classifications (all of which are approximately 1.5 degrees). Although the Morse taper provides a very robust and tight seal, it would actually prove problematic if disassembly of the abutment/implant were needed.

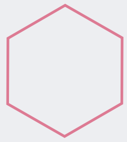






Implant connection geometry

Nobel Conical Connection



12° cone
hex connection

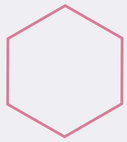
NP-cc RP-cc

Nobel Tri-Lobe Connection

Flat shoulder
tri-lobe connection

NP RP WP

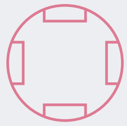
BioHorizons Bone Level



45° cone
hex connection

3.5mm 4.5mm 5.7mm

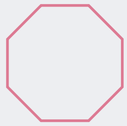
Straumann Bone Level



15° cone
Crossfit connection

NC RC

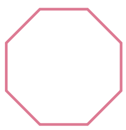
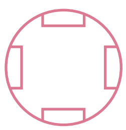
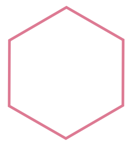
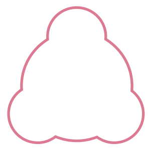
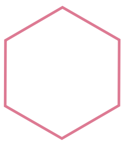
Straumann Tissue Level



8° cone
octagon connection

RN WN

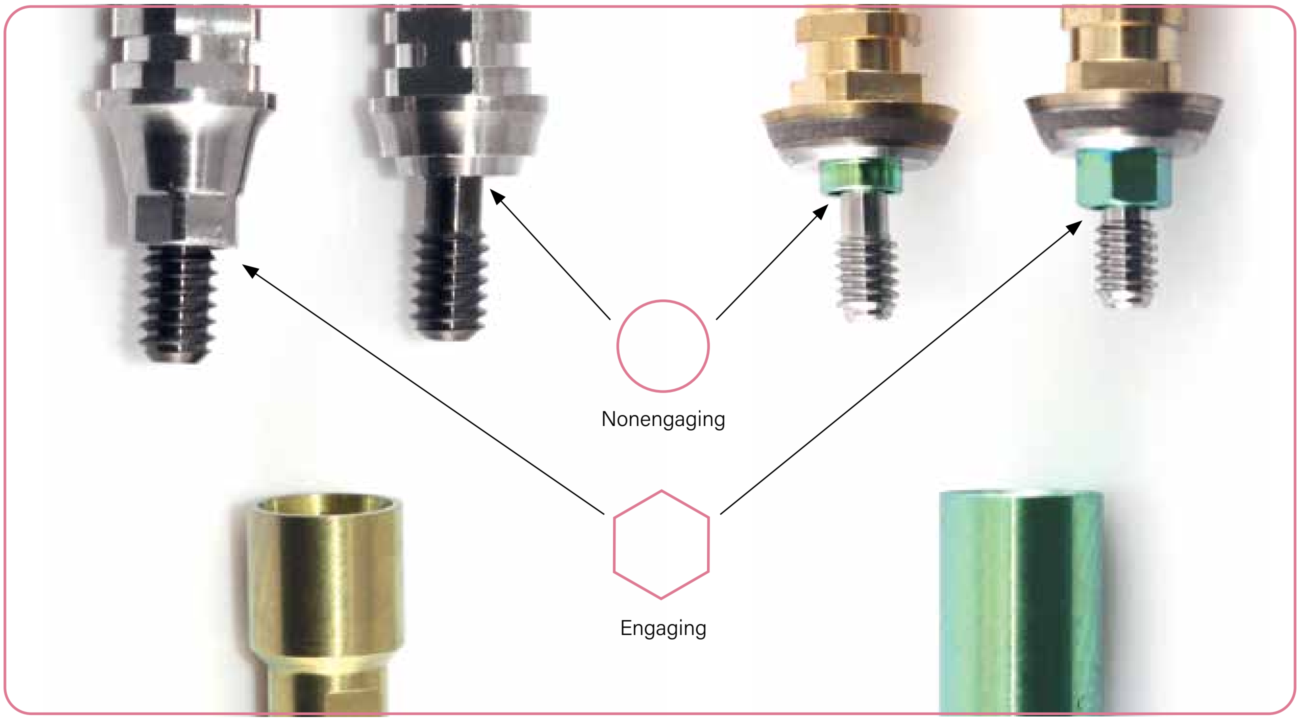
Implant connection geometry

Straumann Tissue Level	Straumann Bone Level	BioHorizons Bone Level	Nobel Tri-Lobe	Nobel Conical Connection
External bevel IAJ	Internal cone IAJ	Internal bevel IAJ	Flat shoulder IAJ	Internal cone IAJ
Octagon connection 	4-sided Crossfit connection 	Hexagon connection 	Tri-lobe connection 	Hexagon connection 
8° cone 45° bevel	15° cone	45° cone	Flat shoulder	12° cone
				
				
				

Implant-abutment junction (IAJ)*

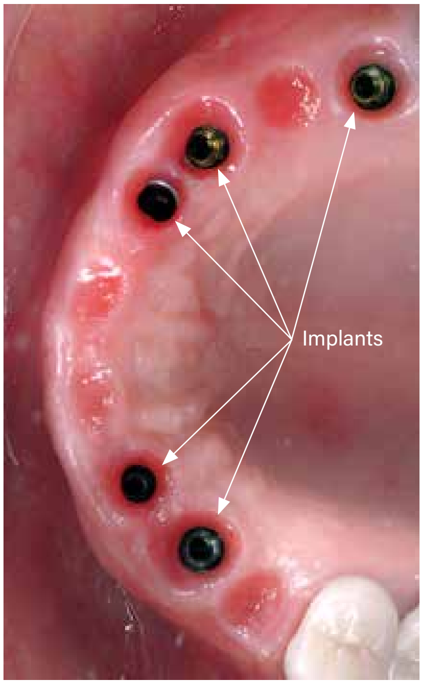
Straumann Tissue Level	Straumann Bone Level	BioHorizons Bone Level	Nobel Tri-Lobe	Nobel Conical Connection
IAJ above bone level	Platform-switched	Platform-switched optional	Straight IAJ	Platform-switched

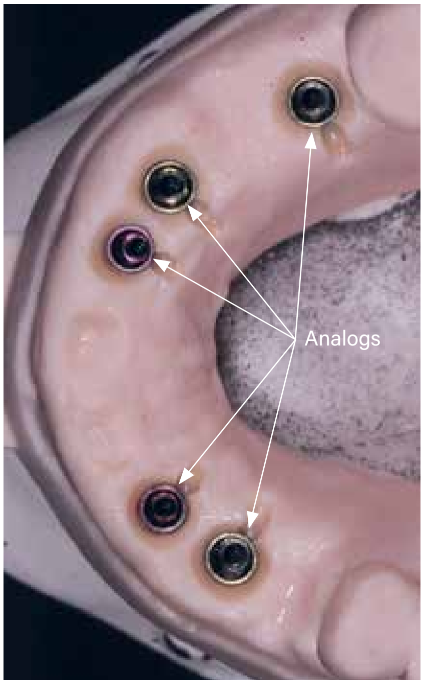
*IAJ marked with arrow.

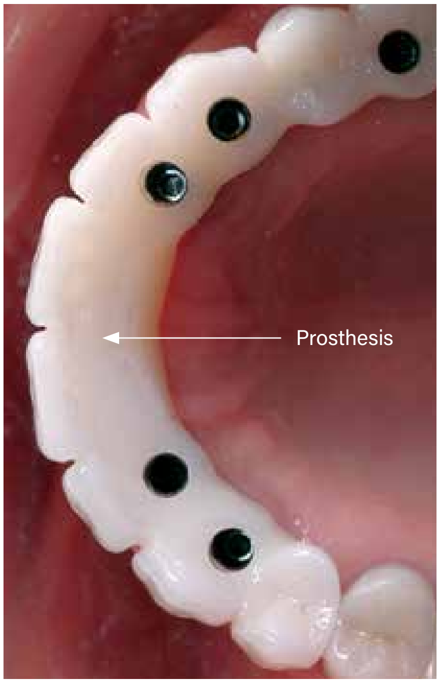


Engaging vs nonengaging

As mentioned previously, the implant has an internal connection area into which the abutment will be attached. In this connection area there is an antirotational feature (hex, lobes, splines, cross, etc). The restorative components for single units need to engage this area so that they cannot rotate, thus the use of "engaging" components. Conversely, a bridge (FDP) does not require the use of antirotational features and may therefore use components that are "nonengaging." There is some variation in the use of engaging and nonengaging components depending on the specific implant system or the specific prosthesis design. Single-unit implants should always use engaging components, both for impression and definitive restoration. For short-span FDPs on two or three implants, use of a single engaging abutment may be advantageous to the stability of the system in the long term (known as "hemi-engaging" FDP). For four or more implants to be combined in a single FDP, use of all nonengaging components is indicated. Some manufacturers fail to offer nonengaging impression copings or abutments, and modification of the components may be required for their use in large treatments. No modification of components should ever be made in the IAJ area where the seal is formed with the implant.







Analog (or replica)

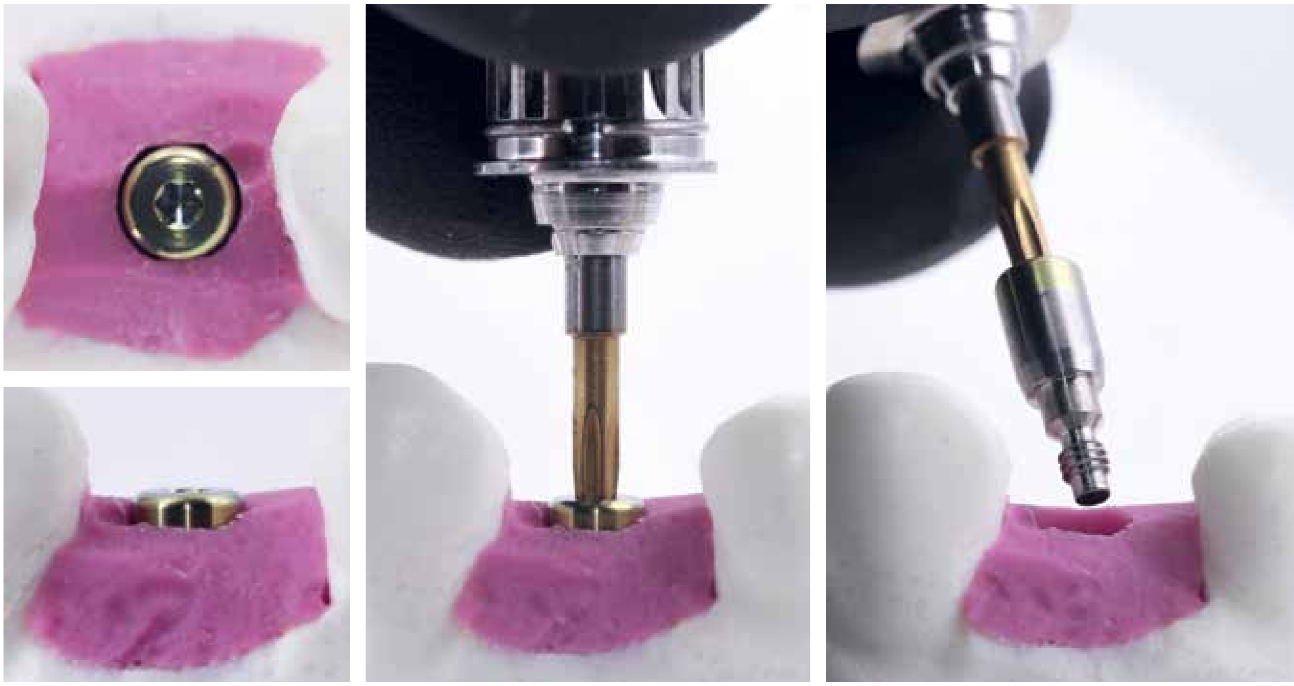
The implant analog is a device that replicates the implant in the laboratory model. It generally looks like a cylinder and may have markings denoting the system being used or the size of the connection. It will be embedded in the stone (or printed resin) model by the technician and serve the role of the implant during restoration fabrication. Analogs are specific to the implant system, connection, and platform size of the implant in place in the patient.

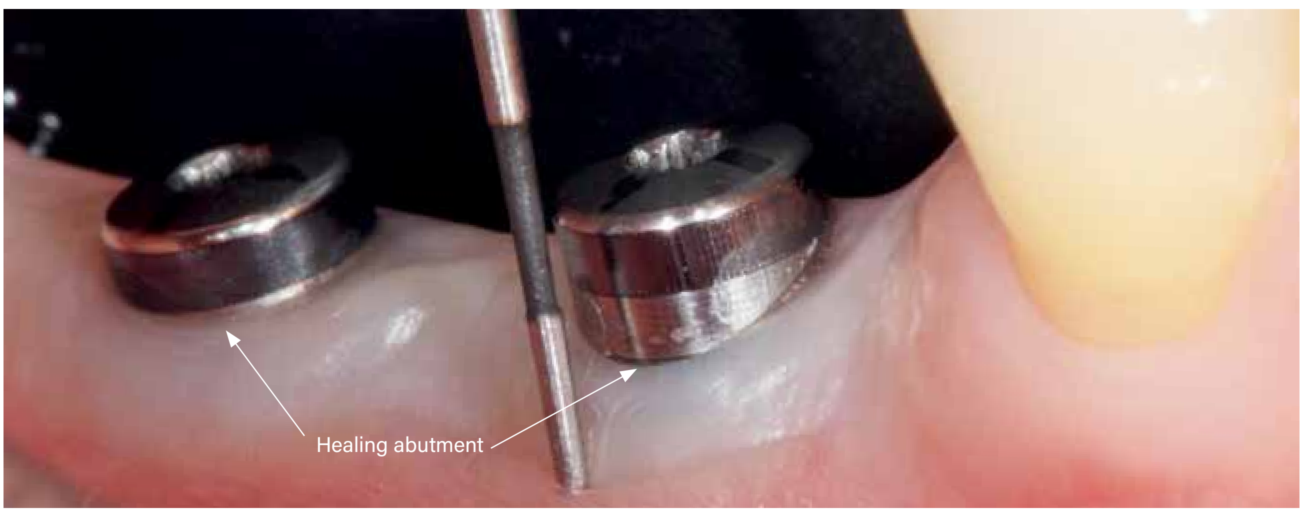
It is common to reuse analogs, but they should be carefully evaluated under high magnification to ensure that they do not exhibit any distortion or damage. Reuse of a damaged analog will lead to problems with fit and passivity of the restoration. It is wise to retain implant models for an extended period of time after case completion before destroying them to retrieve the analogs.

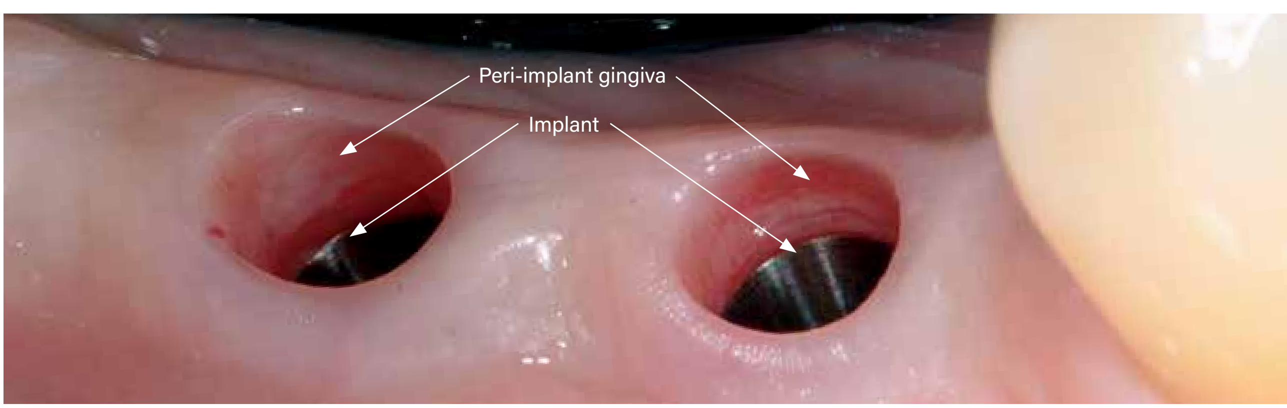
Healing abutments and cover screws

Healing abutments come in various heights and widths. They are specific to the implant system and platform size being used. They are commonly color coordinated to the platform size. In general, the healing abutment should be tall enough to pass through the soft tissue, but short enough so as not to interfere with the opposing dentition. Selection of the diameter is somewhat clinician- and site-specific. Wider healing abutments will form tissue more appropriate to replacing large teeth (ie, molars), while the narrower sizes are conducive to increasing the volume of soft tissue around the implant. In more critical esthetic areas, custom healing abutments or provisional restorations may be advantageous.

The cover screws as seen below are used by the surgeon at the time of implant placement as an alternative to a healing abutment. They are flat and serve to cover the implant and allow for graft materials or soft tissue flaps to be sutured over with full closure. Use of a healing abutment or provisional restoration is called a single-stage protocol, while use of a cover screw is called a two-stage protocol. The use of a cover screw necessitates a surgical "uncovering" appointment following the osseointegration period.




Healing abutment


Peri-implant gingiva
Implant

Impression components

The specific details, indications, and protocols of implant impressions are described fully in chapter 4.

Open tray impression copings

Open tray impression copings are defined by the need to cut open a hole in the occlusal surface of the impression tray above the implants. When the tray is placed into the mouth, the tall pin of the impression coping will pass through the opening in the tray. Once the impression material is set, the pin is unscrewed from the implant, and the coping body is removed from the mouth inside the impression material. Open tray impression copings are sometimes also referred to as "pickup" impression copings. Some manufacturers offer long and short pins to allow for the limitations of working intraorally.

Open tray impression copings are commonly recognizable by their long pins and winglike features.

Closed tray impression copings

Closed tray impression copings do not require a hole to be cut in the impression tray. They are attached to the implant, and the filled tray is placed over them and allowed to set. When the tray is removed from the mouth, the impression coping will still be attached to the implant, at which time it can be removed. Closed tray impression copings are sometimes also referred to as "transfer" impression copings. Some manufacturers also offer closed tray impression copings in various lengths.

Closed tray impression copings are commonly recognizable by their tapered smooth shapes and nonprotruding pin.

Press-fit impression copings

Unlike other impression components, most press-fit copings are held in place with friction instead of a screw. They are commonly made out of an acrylic material called *polyetheretherketone* (PEEK) or some other plastic. While easier to place, they suffer from a passive and unstable connection with the implant. They should be used very cautiously. Some are radiolucent and do not allow seating verification by radiograph. If placed poorly, bumped with an instrument, or bitten on by they patient, they are likely to result in poor-fitting restorations. Some also can double as a scan body for digital impressions.

Digital scan bodies

Digital scan bodies are available for most implant systems/platforms, and they are unique to the system/size implant being scanned. Most are screwed into place and made out of PEEK or titanium, and some also double as press-fit

BioHorizons

Straumann Tissue Level

Straumann Bone Level

Nobel Tri-Lobe

impression copings. Check with your technician before using a new scan body type or a scan body on a new implant system. Not all laboratories have access to all the digital files required.

Various connection sizes

Like most prosthetic components, the impression copings are specific to the platform size and type being restored. They are not interchangeable. Most will be color-coded by the manufacturer to match the rest of that particular platform size.

Various lengths

Most manufacturers offer impression copings in various lengths for both open and closed tray impressions. As a general rule, patients with limited opening or implants further posterior in the mouth will require the use of the shorter impression copings. Longer copings are well suited to the more anterior areas of the mouth. When using short open tray impression copings, the user must ensure that the coping pin is still long enough to pass through the occlusal opening in the impression tray. In more complicated scenarios, a custom tray will be advantageous.

Various widths

Most (but not all) manufacturers offer their impression copings in various widths. While the wider widths are typically used for restoring molars with a proper emergence profile, the user must be aware of the width of the healing abutment currently on the implant. The peri-implant soft tissues can be atraumatically stretched a bit, but attempting to use a wide impression coping on an implant with a narrow healing abutment will require at least some minor resection of the peri-implant soft tissues.

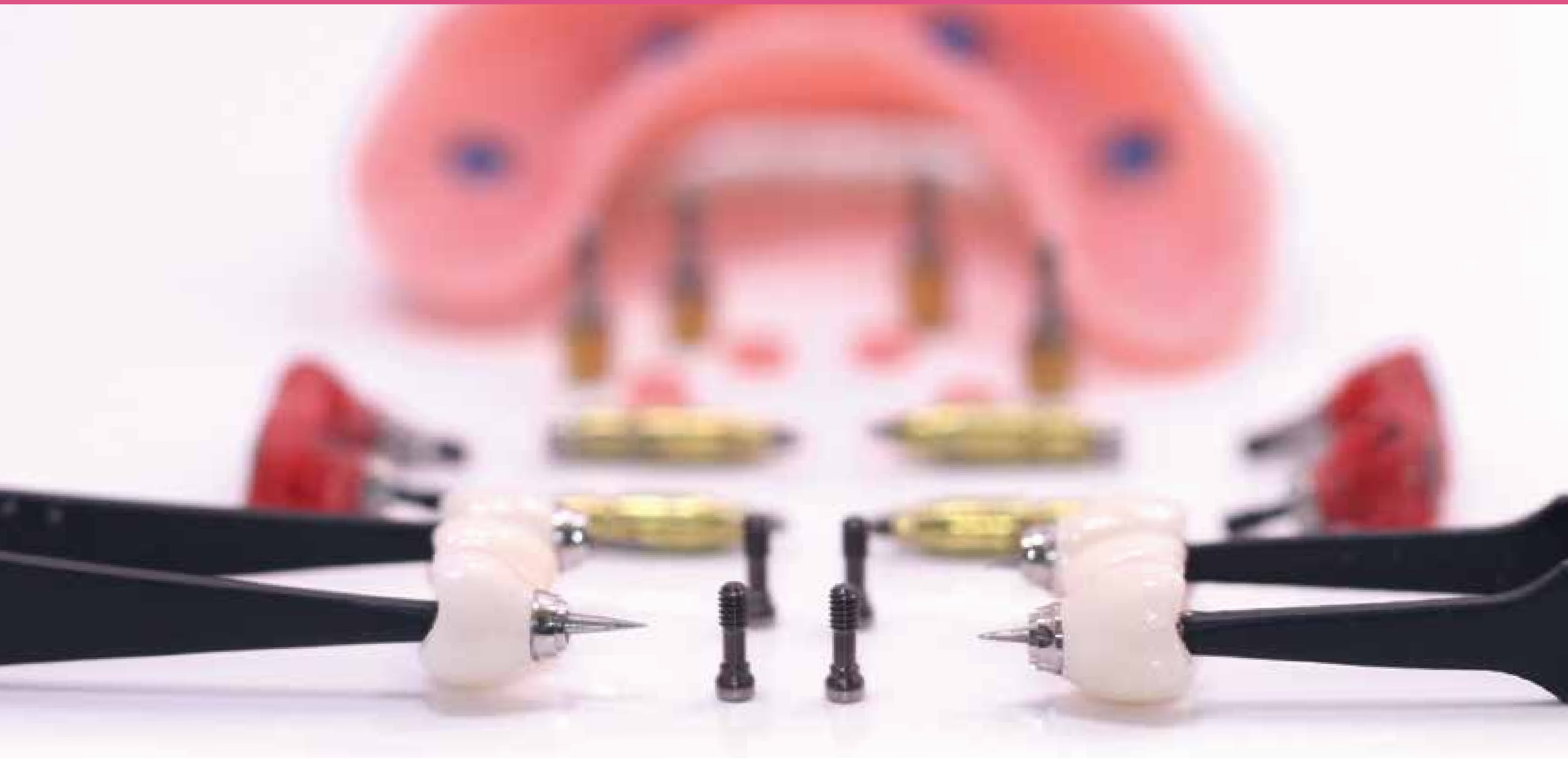
Generally the impression coping width should be selected to most resemble the desired emergence shape of the definitive abutment. Cases where soft tissue positioning is critical should make use of a provisional or custom healing abutment along with a custom impression coping.

Implant System Familiarity

Prior to beginning the process of restoring a dental implant, the clinician must obtain the exact specifics of the implant to be restored. Ideally the surgeon who placed the implant can send a photograph or a copy of the sticker obtained from the implant vial at the time of placement. This will inform the restoring doctor of the exact brand, type, and size of implant that was used. Implants cannot be restored without this information. If the surgeon who placed the implant is unknown or unreachable, the restoring clinician must attempt to identify the specifics of the implant. Though challenging, this can be done with the aid of some websites, consultation with colleagues knowledgeable about implants, through implant-focused social media groups/channels, or consultation with representatives from some implant manufacturers.

The next step is to develop a familiarity with the specifics of the implant system being restored. There are hundreds of operational implant companies, totaling thousands of implant designs. Most are noninterchangeable. Whenever possible, any and all components should be sourced from the implant manufacturer to ensure the integrity of the system and minimize complications. Common third-party claims of "compatibility" do not necessarily mean the same precision of fit or manufacturing. As with any highly engineered system, the highest levels of precision are requisite for minimizing complications. This is especially true in the small, complicated, demanding world of dental implants.

If this is your first time attempting to restore a particular implant system, most manufacturers offer PDFs or video tutorials related to their system. Some may have representatives that can come to you in person to assist you in learning about the system. The protocols and techniques described in this text will work with most modern implant systems, though the particular nomenclature or details may vary slightly. Do not attempt to restore an implant without understanding it prior to the procedure. You should be familiar with platform design, the connection interface, the impression components, the prosthetic components, the use and selection of appropriate drivers, use of the torque wrench, specified final torque levels, and the desired restoration type and materials.



Unique Challenges to Handling Implant Components

Most tooth-borne dentistry involves large hand instruments and teeth securely attached to the jaw. Implant dentistry by contrast mostly involves the use of very small instruments and components, all of which must be attached to the implant. As such, the rules of handling items in the oral environment is much more challenging and potentially dangerous. Every effort should be made to ensure that no component is ever dropped or left unsecured. No instrument or component is to be left in the mouth without being screwed in or cemented. Gloves should be latex for their superior tactile feel and less slippery surface. Clinicians may opt to go down a size in gloves to improve dexterity. Gloves and instruments must be clean and dry at all times. Extensive amounts of gauze should be readily available to enable quick drying of gloves and components.

Gauze is also to be used to serve as a backup protection for the airway should something be dropped. However, this is not foolproof, especially in the molar regions. When used, it should be kept off the tongue and the floor of the mouth where it tends to absorb saliva and can result in a more dangerous situation. It will need to be replaced frequently throughout the procedure. But again, this airway protection is a distant backup plan. The most effective way to avoid a patient swallowing or aspirating a component is to never drop one in the first place.

Patient positioning is often a result of individual preference. Many beginners to implant restorations may feel safer having the patient in an upright position, the idea being that if something is dropped, it will go to the floor of the mouth instead of the back of the throat. While this may seem intuitive, having a patient seated in an upright position produces an uncomfortable and unhealthy position for the clinician, can drastically limit visibility, and creates an environment where one might feel that dropping of instruments or components is inconsequential—none of which is conducive to learning how to restore implants in all areas of the mouth. And an upright patient makes restoring maxillary implants increasingly difficult as gravity is now working against you.

It is my preference to operate with the patient in a fully supine position, with appropriate airway protection and serious attention to proper handling of the components to eliminate them being dropped. It is my belief that we operate better when we learn to operate from the same position. It creates one less variable to adjust to and creates a sense of familiarity for the doctor and assistant (nurse).

Chapter 3 covers the specifics of instrument handling in detail. It should be read in great detail. The detailed strategies and techniques there will save you a great deal of stress and minimize the challenges of handling implant components in the oral environment.

Drivers

The implant screw driver (commonly referred to simply as a *driver*) is used to attach and remove components from the implant. There are many variations/sizes, and once again they are mostly manufacturer specific and not interchangeable. The early implant drivers were a "slot" type, resembling a small flathead screwdriver. Modern implant screw drivers are more sophisticated. They come in many geometries. Many are a hex shape (eg, BioHorizons, Astra, Zimmer), some are square shaped (eg, 3i), and some are Torx shaped resembling a six-pointed star (eg, Nobel and Straumann). There are a few other esoteric designs in the market as well. Some drivers have a parallel interface, while others have a tapered interface. While they may be described as being the same size, a parallel hex driver that is the same size as a tapered driver will fail to reach the proper torque. Under all available circumstances, users should attempt to use components including screws and drivers from the same implant manufacturer to avoid complications.

Manufacturers are increasingly releasing new driver/screwhead designs that allow the driver to be used from a slight angle—purportedly to allow a screw-retained restoration in the esthetic zone, even when the implant is angled to the facial. Again these are specific to the manufacturer. Use of angled screw systems looks promising in early in vitro data, but they should be used cautiously until long-term clinical data can be reported.

Drivers come in various lengths. It is advisable to have all available lengths on hand for all implant procedures. Short drivers are useful for attaching and removing impression copings. Medium-length drivers are useful for most healing abutment sites and for delivering most abutments/prostheses. Long drivers are necessary for delivering screw-retained restorations, especially in the esthetic zone.

Additional specifics regarding drivers and their use are covered in chapter 3.

Torque wrenches

The abutment screws are engineered to safely and reliably operate when tightened to a very specific value. The torque wrench allows all users to properly tighten the abutment screws according to the manufacturer-specified torque value. Most definitive abutment screws are designed to be tightened to 25–35 Ncm. Some smaller screws are only designed to be torqued to 10–15 Ncm. Proper use of the torque wrench is imperative to avoid undertightening of screws (which leads to loose screws) or overtightening of screws (which can cause stripped or broken screws).

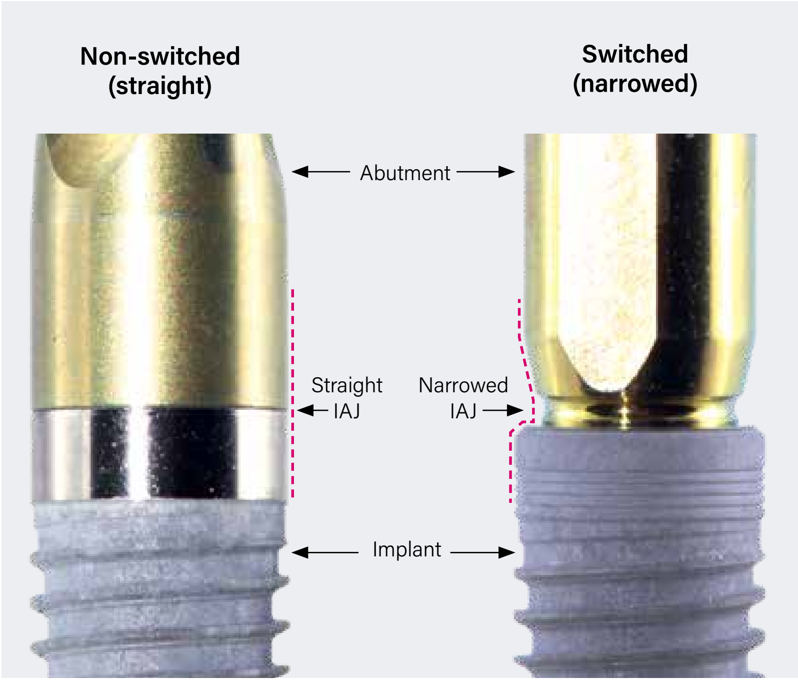
Torque wrench design, usage, and markings can vary. One must pay close attention to avoid iatrogenic difficulties. Proper use of torque wrenches is thoroughly explained in chapter 3.

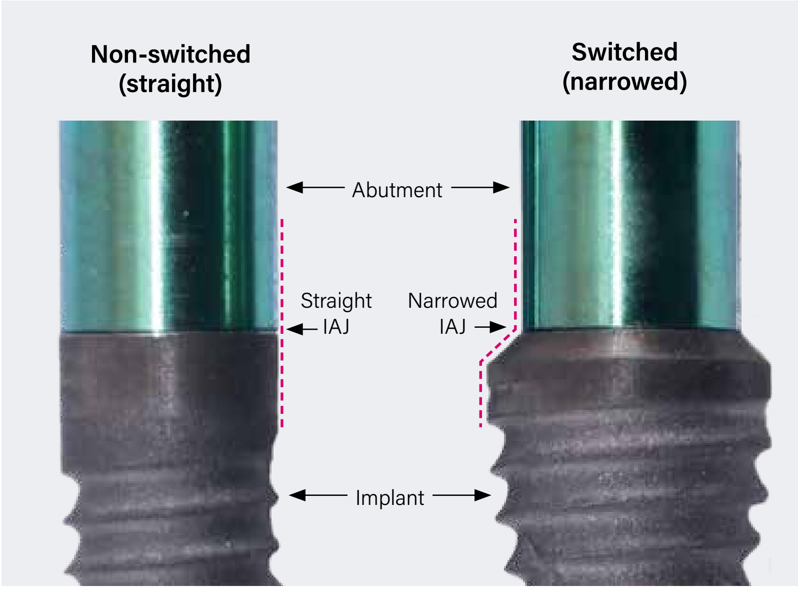
Platform-switched implants

Most currently available implants are of the bone-level design. But within this class of implants there are two variations: non–platform-switched and platform-switched. The non–platform-switched implant has an abutment that starts at the IAJ in the same diameter as the head of the implant. The platform-switched implant, however, has an abutment that starts at the IAJ narrower than the implant. The rationale behind this design feature is to move the IAJ inward and away from the crest of peri-implant bone. Most (but not all) clinical data show some degree of improvement on the peri-implant bone levels over time with the platform-switch feature. The increase in bone levels is notable but perhaps not critical in all treatment scenarios.

The exact reasons for the improved bone around platform-switched implants appears to be multifactorial. First, there is micromovement between the abutment and the implant at the IAJ over time; moving this away from the bone may protect it somewhat from the effects of movement and leakage. Second, the abutment surface is not generally conducive to osseointegration (bone attachment), and moving it further away from the bone may reduce the remodeling of peri-implant bone away from nonintegrating materials. Narrowed abutments may also reduce the chance of excessive pressure being placed on the peri-implant bone and soft tissues throughout the restorative stages, thus reducing iatrogenic bone loss.

Non-switched and switched implants





Implant Restoration Design Variables

Screw-retained restorations

Screw-retained restorations are a single-piece restoration where the abutment and crown operate as a single piece. There are many variations to their design and materials. In their earliest form, they consisted of a cast metal abutment to which feldspathic porcelain would be stacked. These are commonly referred to as *UCLA abutments* owing to their development at UCLA in 1988. More modern iterations have moved to a titanium base abutment to which a reinforced porcelain crown, like lithium disilicate or zirconia, is cemented. The titanium base can be a stock component or a custom milled component. There was a time where the entirety of the abutment would be milled in zirconia, including the connection area that engages inside the implant. However, this design proved clinically to be insufficiently robust, resulting in broken abutments and frustrated clinicians and patients.

Regardless of the materials or design, the screw-retained restoration has the abutment and the crown connected together in the laboratory through various means. The screw channel remains open (usually on the palatal or occlusal surfaces) to allow the screw to be placed and torqued. After




delivery and torquing, the screw must be covered with a nonporous, resilient material that allows future clinicians to gain access to the screw if the need arises. This material is then covered with a more robust material (usually composite) up to the occlusal or palatal surface.

The indications and contraindications, advantages and disadvantages, and delivery protocols of the screw-retained restoration are fully flushed out in chapter 5.

Cement-retained restorations

Cement-retained restorations are a two-piece restoration where the abutment and crown are separate until delivery. The crown and abutment are held together with cement, much like a tooth-borne restoration. The abutment can be stock or custom milled. Common modern materials for the abutment are titanium, anodized (yellow-color) titanium, or a titanium-zirconia hybrid. The abutment is held to the implant with the abutment screw and torqued to the specified value. The screw is then covered with a nonporous, resilient material. The crown is then cemented to the abutment.

Cement-retained restorations have ebbed and flowed in popularity. The lack of easy retrievability, should the need arise, coupled with the possibility of a poorly designed abutment with deep margins or tissue-level implant with deep margins leads to a high incidence of residual cement being left in the sulcus, where it causes peri-implantitis and potentially implant failure. Nevertheless, if properly used, cement-retained restorations have shown comparable levels of success and survival to screw-retained restorations in numerous systematic reviews.




The indications and contraindications, advantages and disadvantages, and delivery protocols of the cement-retained restoration is fully flushed out in chapter 5.

Splinted/nonsplinted restorations

Adjacent implants can have individual restorations or a single combined restoration (see below). Numerous considerations must be thoughtfully addressed when making the decision to splint or not. It is unscientific and disingenuous to apply a single treatment modality to all patients and all clinical scenarios.

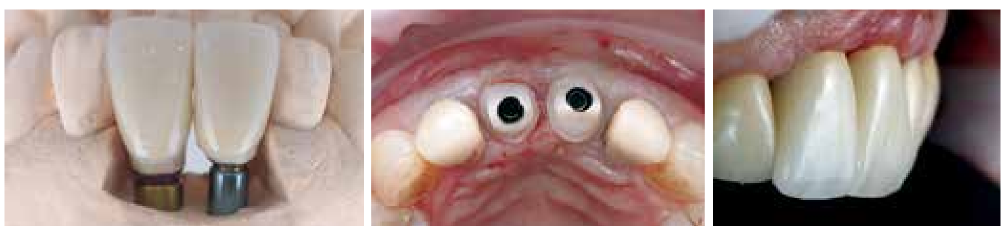
Numerous in vitro studies (primarily finite element analyses and photoelastic gel tests) have repeatedly shown some degree of decreased stress in the peri-implant crystal "bone" with splinted restorations. However, nearly all short- and long-term clinical trials (many of them split-mouth designs) have failed to show that this stress differential between splinted and nonsplinted restorations resulted in any clinically significant differences in peri-implant bone levels.

"Stress distribution" is not a scientifically backed rationale for splinting adjacent implants under normal scenarios. However, sound reasons to splint adjacent implants do exist: reduction of screw loosening, ease of delivery (one fewer interproximal contact), stabilization of compromised implant lengths/diameters, use of pink porcelain, or use of a cantilevered pontic. Indications for nonsplinted restorations include patient preference (commonly), esthetics, reduced cost, and complications for replacement/repair in the event of problems with one unit.

Individual restorations

Nonsplinted screw-retained

Nonsplinted cement-retained



Combined restoration

Splinted screw-retained

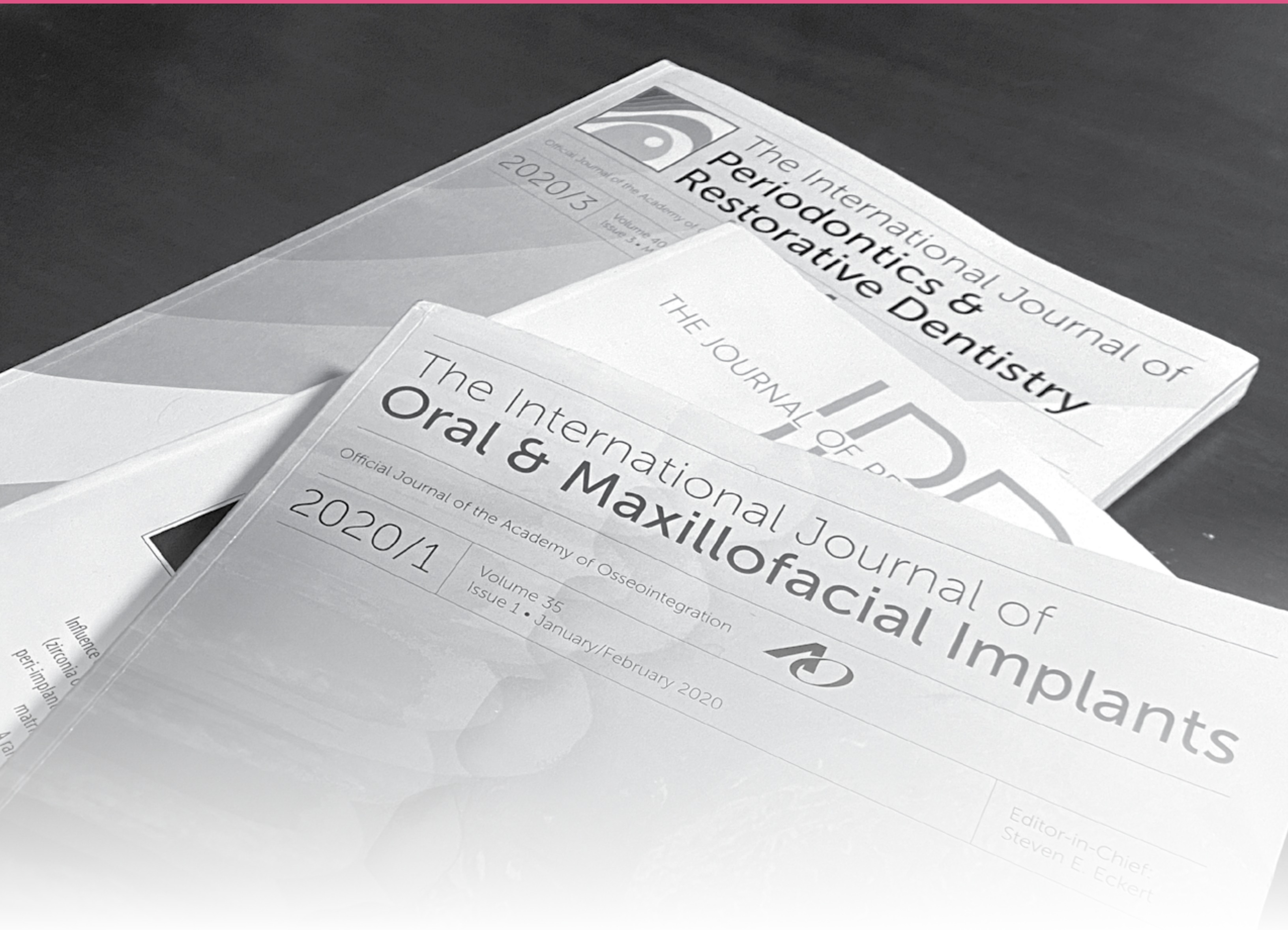
Splinted cement-retained

Practice and Training

It is my goal for this text to serve you as a highly valued reference in your career of restoring dental implants. However, reading can only get us so far in our learning curve. As one of my biostatistics professors liked to say, "You can't learn to fly a plane from a book!" As such, you should find time to practice the art of implant restorations—practice that does not involve patients. Many manufacturers have training models that may be available to borrow with which you can touch and feel the individual components of that system so you can learn how to hold and position them without the added stress of treating a patient.

Dentistry is an operational profession. We operate on people. The best way to become comfortable with any operative profession is to get hands-on training. You should continually seek out mentors and teachers who can assist you with this process. There are many excellent courses offered all over the world to aid you in learning how to restore dental implants. With the right educators and training program, you will find your comfort and confidence significantly increase.

This text will ensure that you are on the right track with your understanding of restoring implants. The indications, rationale, protocols, and techniques are explained in great detail. There are videos to demonstrate various procedures (look for the QR codes). There are checklists in the appendix that you can and should use during the procedure to see that all steps are followed and in the correct order.



Reviewing Implant Literature

Implant prosthodontics is evolving at a rapid pace. The designs and materials vary significantly from those in use just a few years ago. As such, many of the common “rules” or “guidelines” of implant dentistry date back to a time when we were restoring very different implants with very different restorations using significantly less scientific evidence. If restoring dental implants is to be a significant part of your practice life, you should be reading the dental implant literature. There is good information available from a wide variety of dental journals and magazines. The journals tend to be a bit more scientific in their approach and have a more vigorous vetting process. The magazines will tend to have more examples of a clinical case or a technique, produced with less rigorous oversight. Both information channels will be useful to you, but in different ways. The information in the journals will tend to be more reliable, less biased, and more cutting edge. The magazines will be more useful to see the best of what might be possible. But do understand that the cases an author chooses to write up and publish are going to be the best of their best. These are unlikely to be their “normal” results. It is useful to see what a skilled, thoughtful, and honest clinician is able to accomplish.

If reviewing the dental implant literature seems too time-consuming or confusing, seeking out a well-informed mentor will serve you well. They will able to help guide you through the hundreds of decisions we must make at every procedure with results based on high levels of scientific evidence and clinical results.

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Page numbers followed by "t" denote tables; those followed by "f" denote figures.

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