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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 the QR code at right. 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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Nobel Biocare Endowed Chair, Surgical Implant Dentistry
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 osseointegration 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 osseointegration, 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

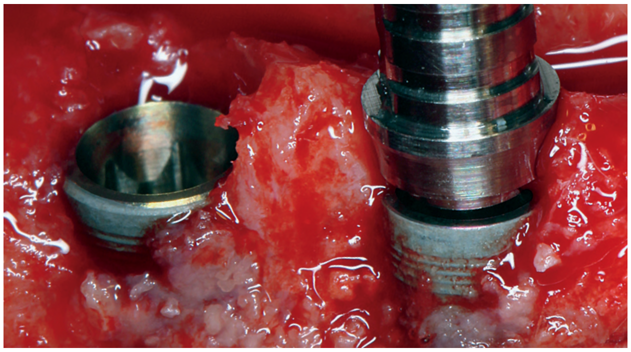
The platform is the area at the head of the implant where the abutment meets the implant. Platform sizes vary between manufacturers. They may be denoted by a measurement, a few letters, a color, or some combination of these. As the clinician restoring the implant, it is critical that you determine the 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.

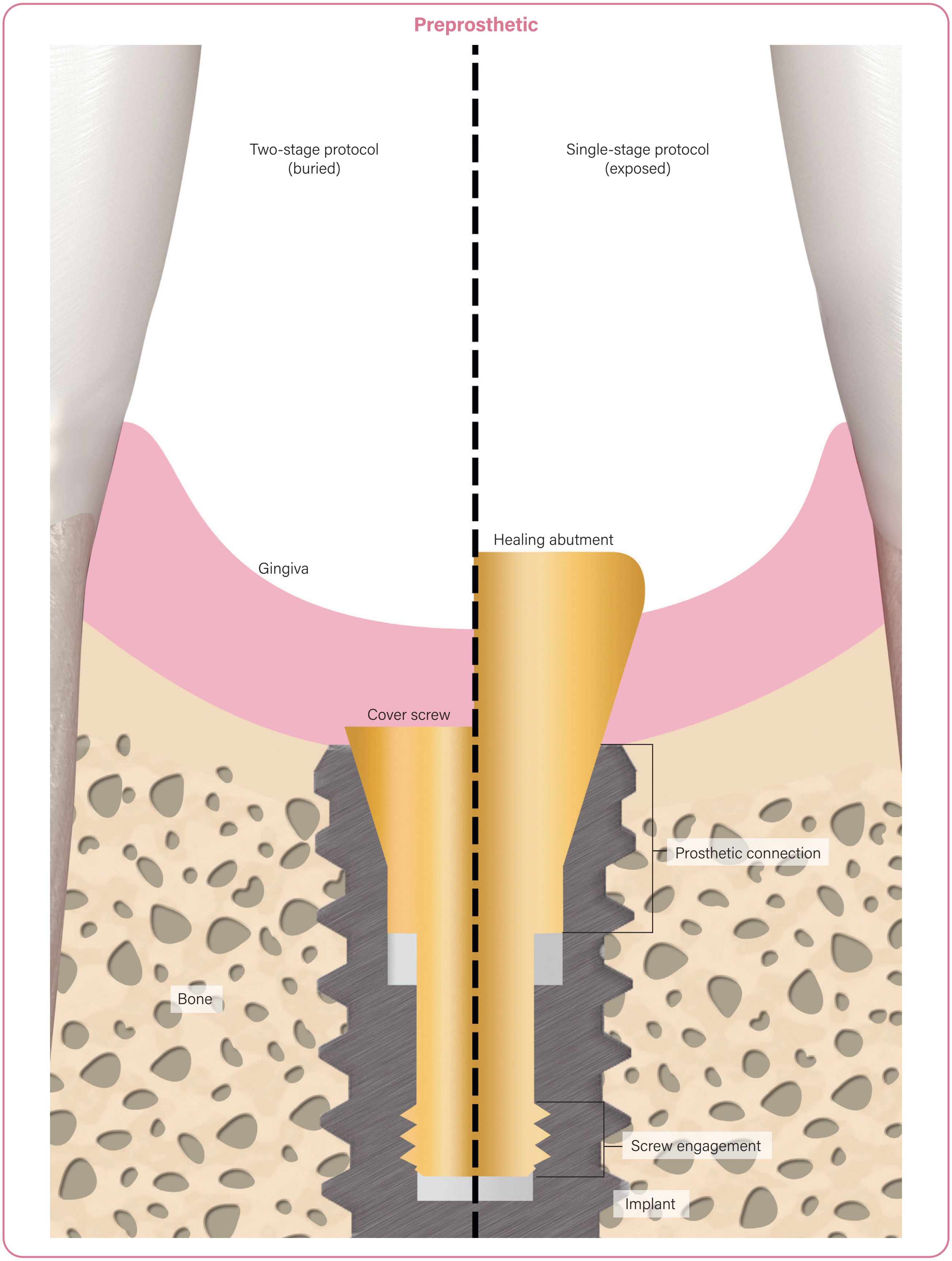
Connection

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
Two-stage protocol
(buried)
Single-stage protocol
(exposed)
Healing abutment
Gingiva
Cover screw
Prosthetic connection
Bone
Screw engagement
Implant

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.

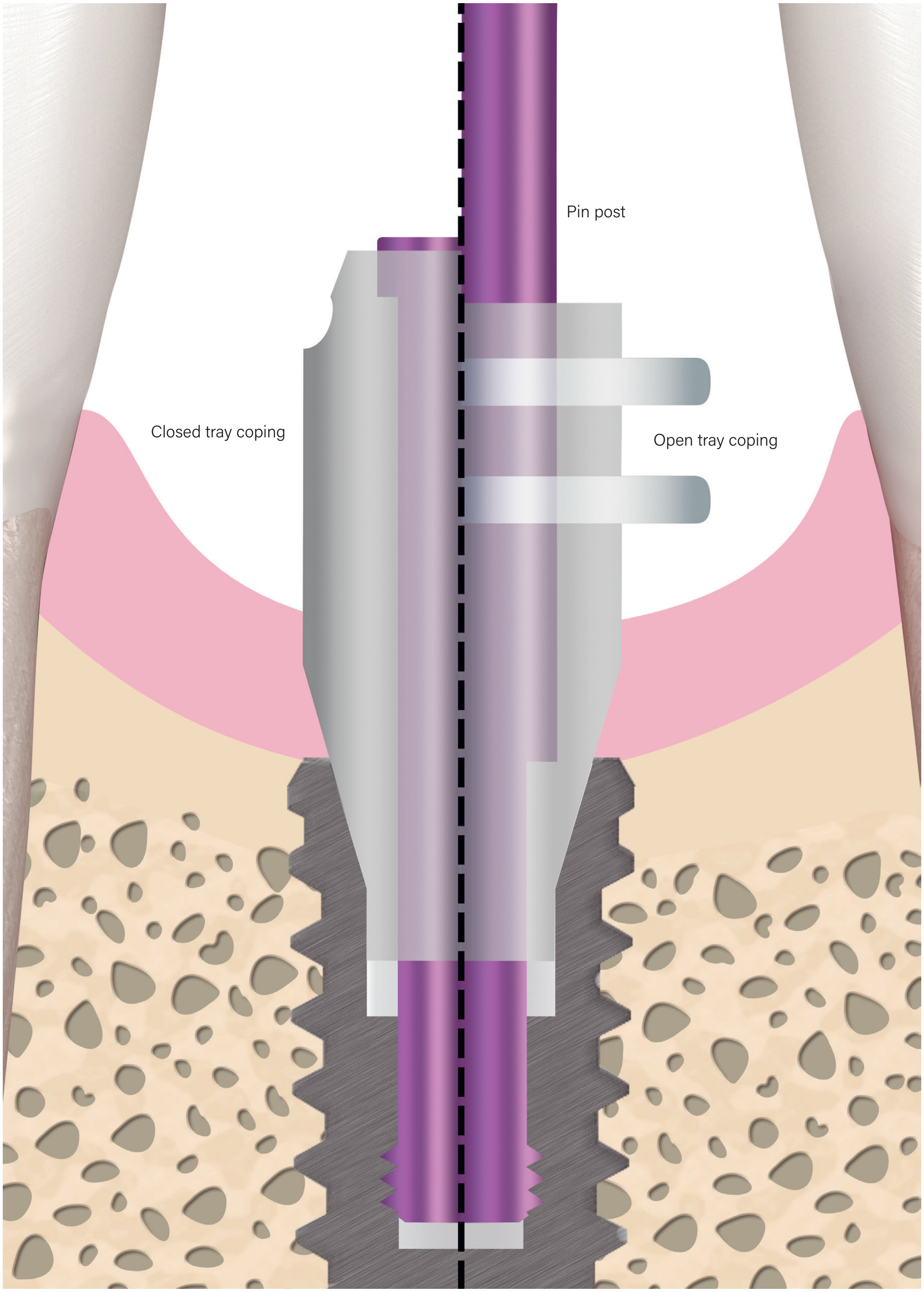
Seating

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.

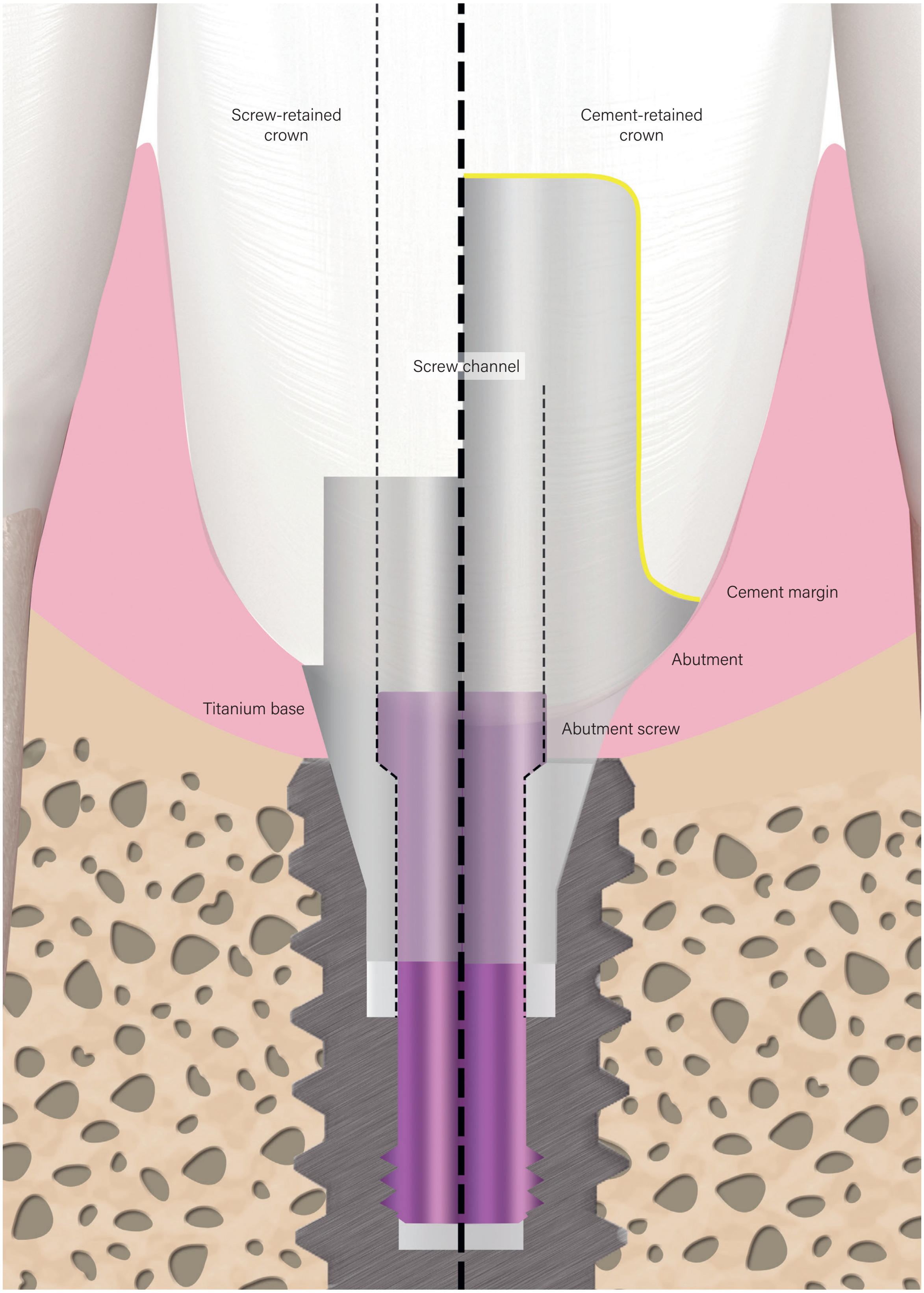
Torque

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

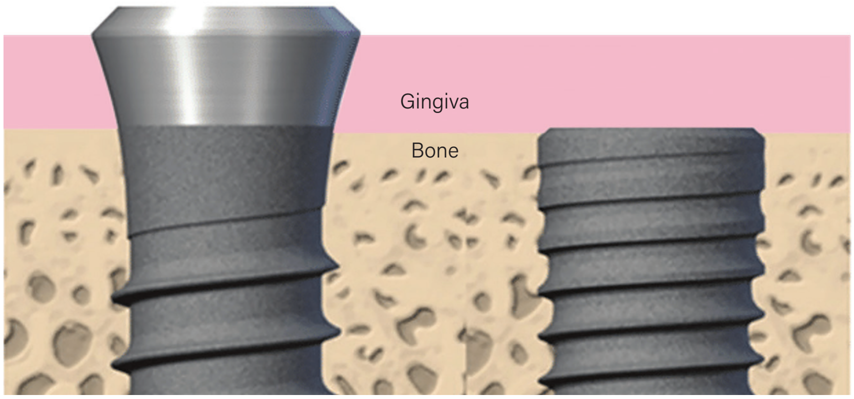
The driver is the small screwdriver-like device that fits precisely into the screw and allows the user to tighten or loosen it. In implant prosthetics, there are numerous driver types/sizes, and the clinician must be very conscientious of using the exactly correct driver. Use of an incorrect driver will 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



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.

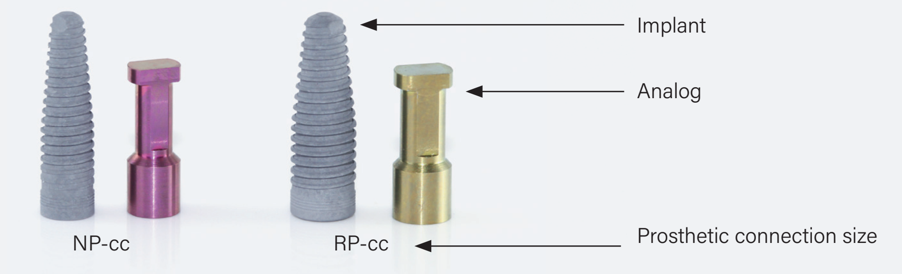
Most currently available implants are of the **bone-level** design, where the head of the implant is designed to be placed at or slightly below the crest of bone. This is a bit of an oversimplification as the bony crest is rarely completely flat mesiodistally and buccopalatally. Alternatively, a few 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

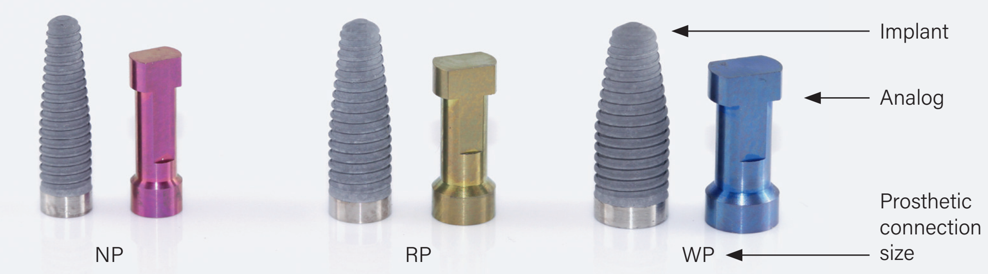
In some implant systems, each implant diameter has only one matching platform size. However, it is increasingly common for various implant diameters to have the same platform size. Below is an example from BioHorizons where the implant body diameters vary but share a platform size as identified by the 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

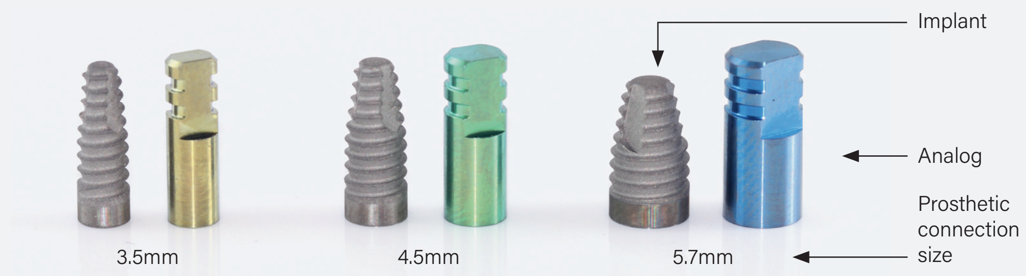
Nobel Conical Connection



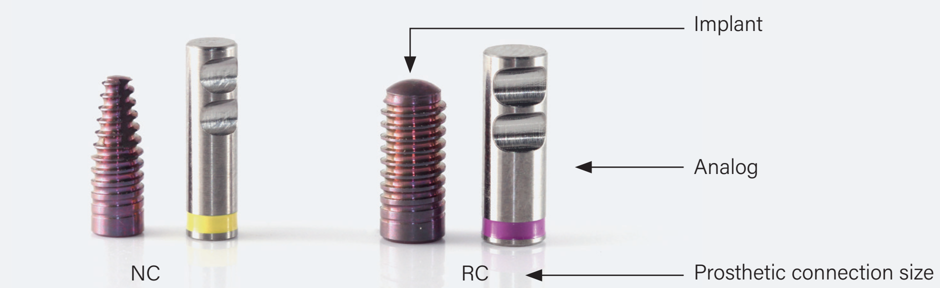
Nobel Tri-Lobe Connection



BioHorizons Bone Level



Straumann Bone Level



Straumann Tissue Level

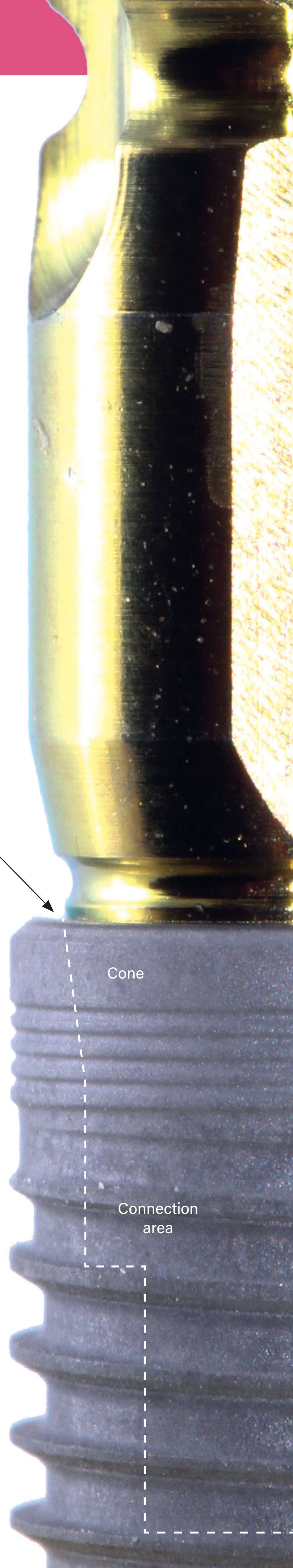
Implant connections

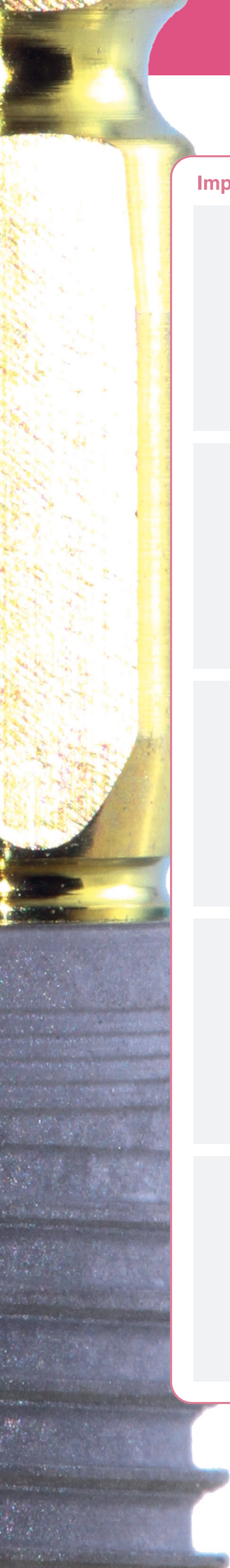
The connection area (ie, hex, trilobe) is a critical design feature of the implant. Its primary role is to prevent rotational motion of the abutment or prosthesis. It accomplishes this through the use of some geometric internal feature. As seen on the facing and following pages, manufacturers employ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

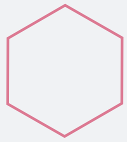
When tightened to the specified torque value, the abutment screw is slightly stretched and acts like a stretched spring that pulls the abutment into the implant and keeps it seated under tension. As mentioned earlier, this engineering principle is called *preload*. The seal between the abutment and the 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



12° cone
hex connection

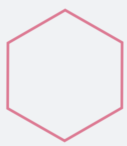
Nobel Conical Connection

NP-cc RP-cc

Flat shoulder
tri-lobe connection

Nobel Tri-Lobe Connection

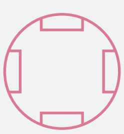
NP RP WP



45° cone
hex connection

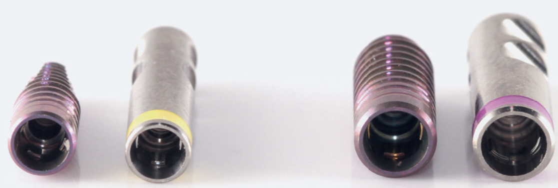
BioHorizons Bone Level

3.5mm 4.5mm 5.7mm

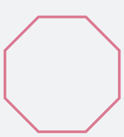


15° cone
Crossfit connection

Straumann Bone Level



NC RC

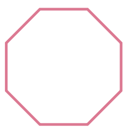
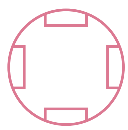
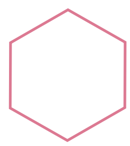
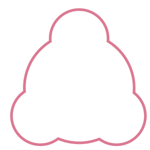
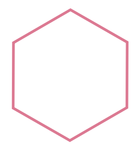


8° cone
octagon connection

Straumann Tissue Level

RN WN

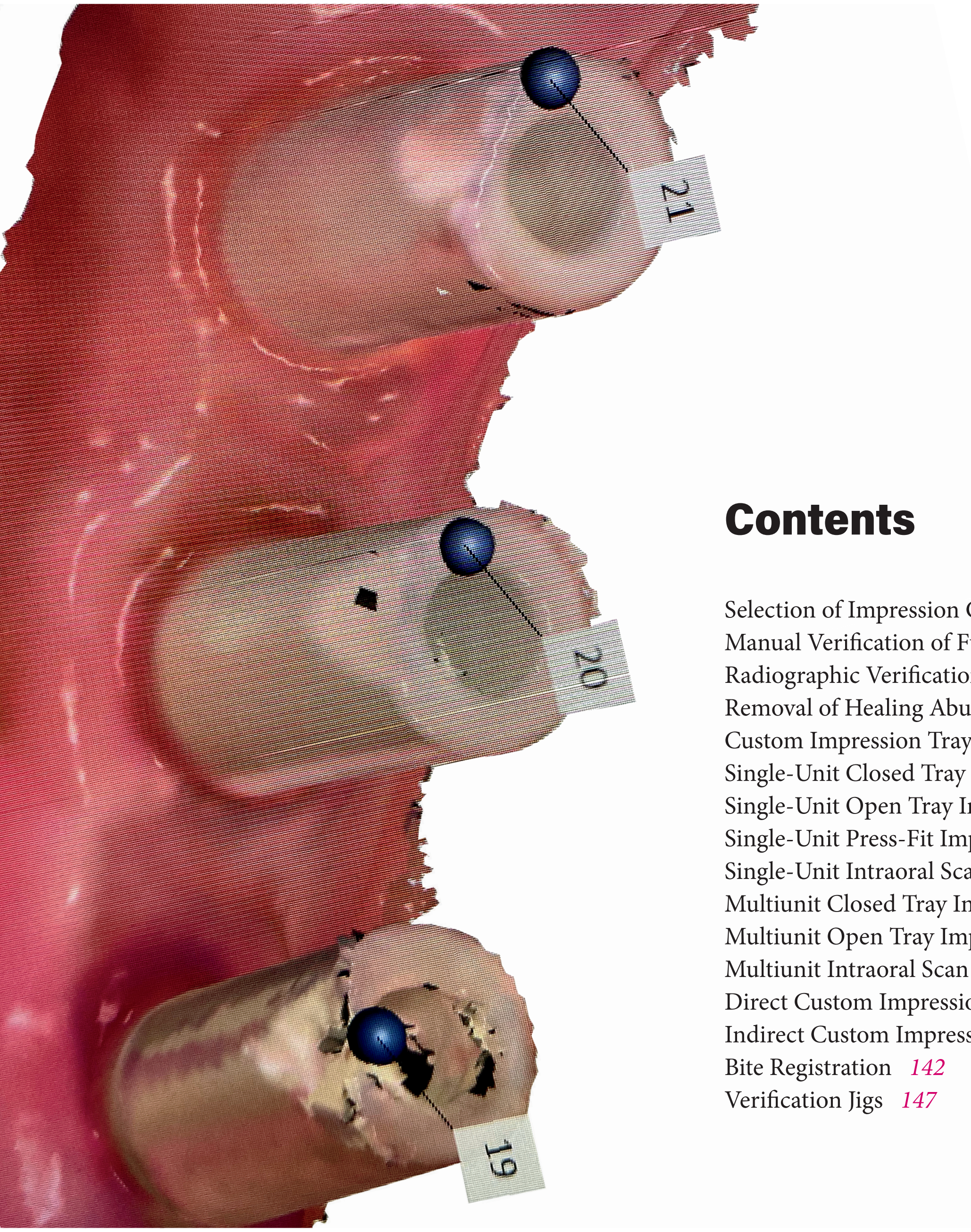
Implant connection geometry

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.



Contents

How to select implant impression components: Determine the...

Implant manufacturer
(ie, BioHorizons, Nobel, Straumann)

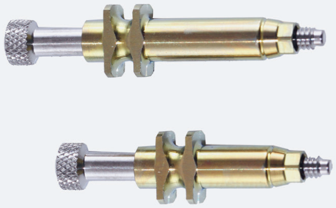
Implant connection
(ie, tissue-level or bone-level)

Platform size
(ie, NP, RP, WP)

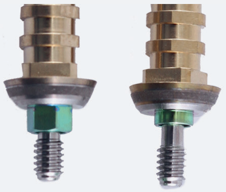
Impression type
(ie, digital, closed, open)

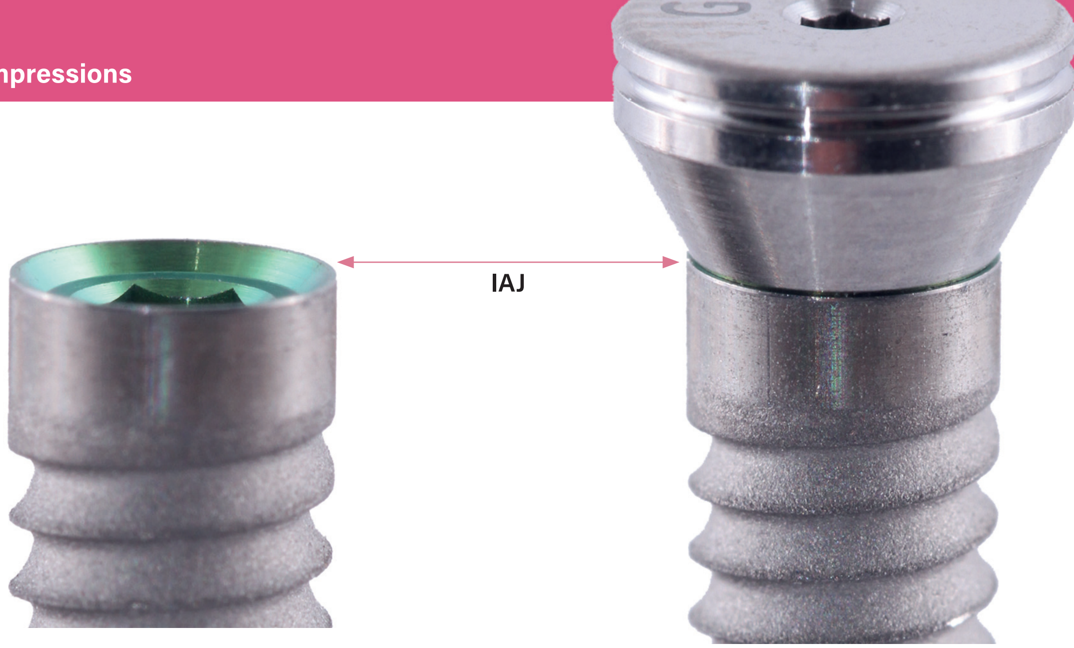
Desired emergence width
(ie, narrow, regular, wide)

Impression coping length
(ie, short, long)



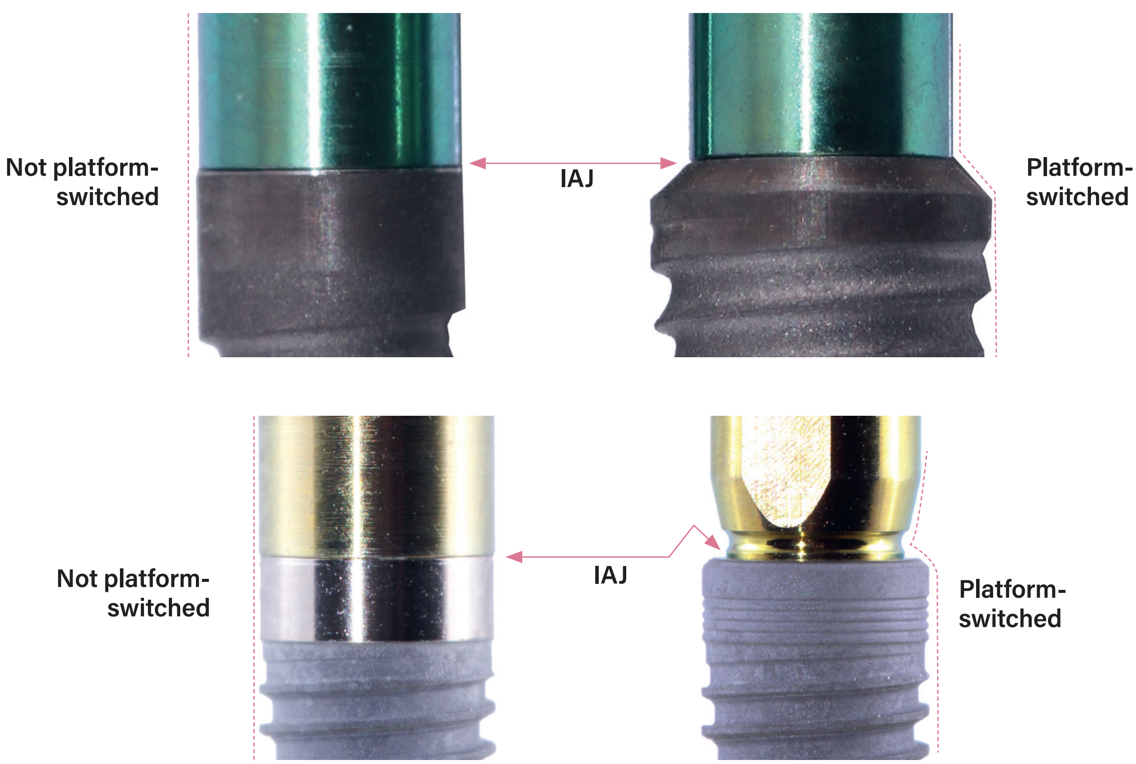
Engaging or nonengaging
(For single units) (For FDPs)



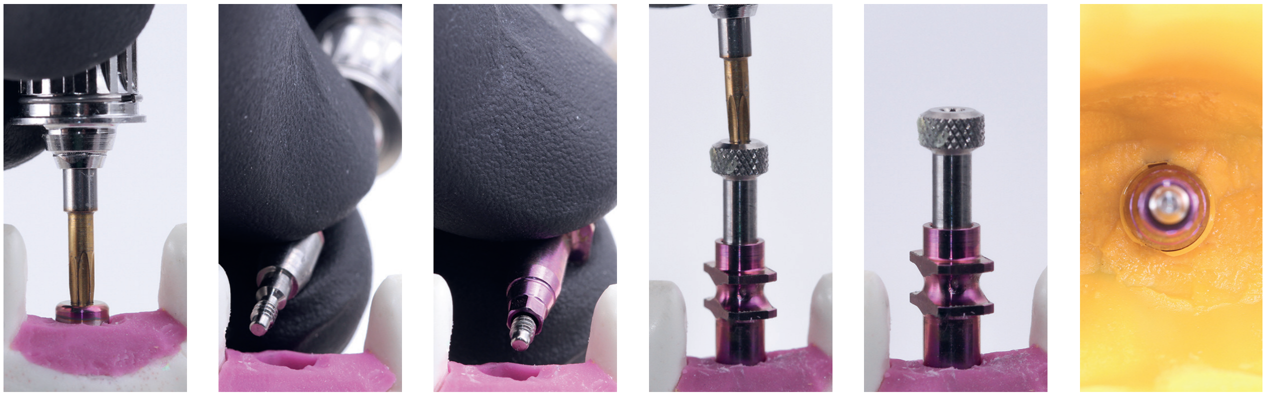


As described in chapter 1, the IAJ is the critical mating surface between the implant body and the prosthetic components. It is imperative that all components (cover screws, healing abutments, impression copings, definitive abutments/restorations) are fully seated into the implant and that the IAJ is fully closed. Complete seating of components can and should be verified with a radiograph (as described in the next section), but the manual verification technique described here will save time, minimize complications, and reduce the need for repeated radiation exposures.

The IAJ design varies between manufacturers and implants (see images below). Some have a flat shoulder with no platform switching (ie, Nobel Tri-Lobe), some have a narrow tapered cone shape (ie, Straumann Bone Level, Nobel Conical Connection), and others have a bevel shape (ie, BioHorizons, Straumann Tissue Level). It is important for the clinician to know what the IAJ design is prior to attempting to determine if the components are fully seated manually or radiographically. Review chapter 1 for further details on the design of individual connections. Some systems have a platform-switched design where the prosthetic components are narrower than the implant. This offset or notch is not to be mistaken for unseated components.

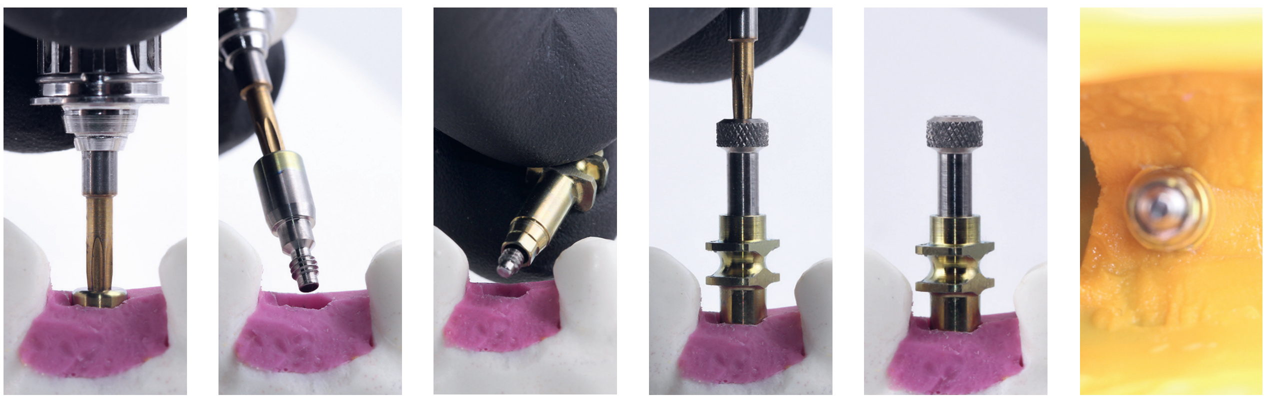


Remove healing abutment → Attach open tray coping → Radiograph → Impression



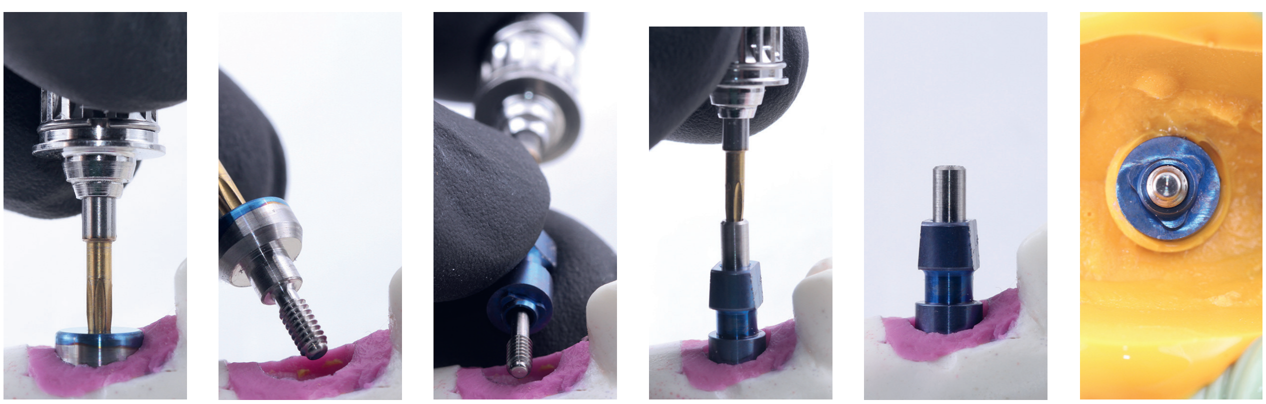
Driver: Nobel Uni-grip

Nobel Conical Connection
Narrow Platform
NP-cc (pink)



Driver: Nobel Uni-grip

Nobel Conical Connection
Regular Platform
RP-cc (yellow)



Driver: Nobel Uni-grip

Nobel Tri-Lobe Connection
Wide Platform
WP (blue)