Periodontal and Peri-implant Plastic Microsurgery:

Minimally Invasive Techniques with Maximum Precision

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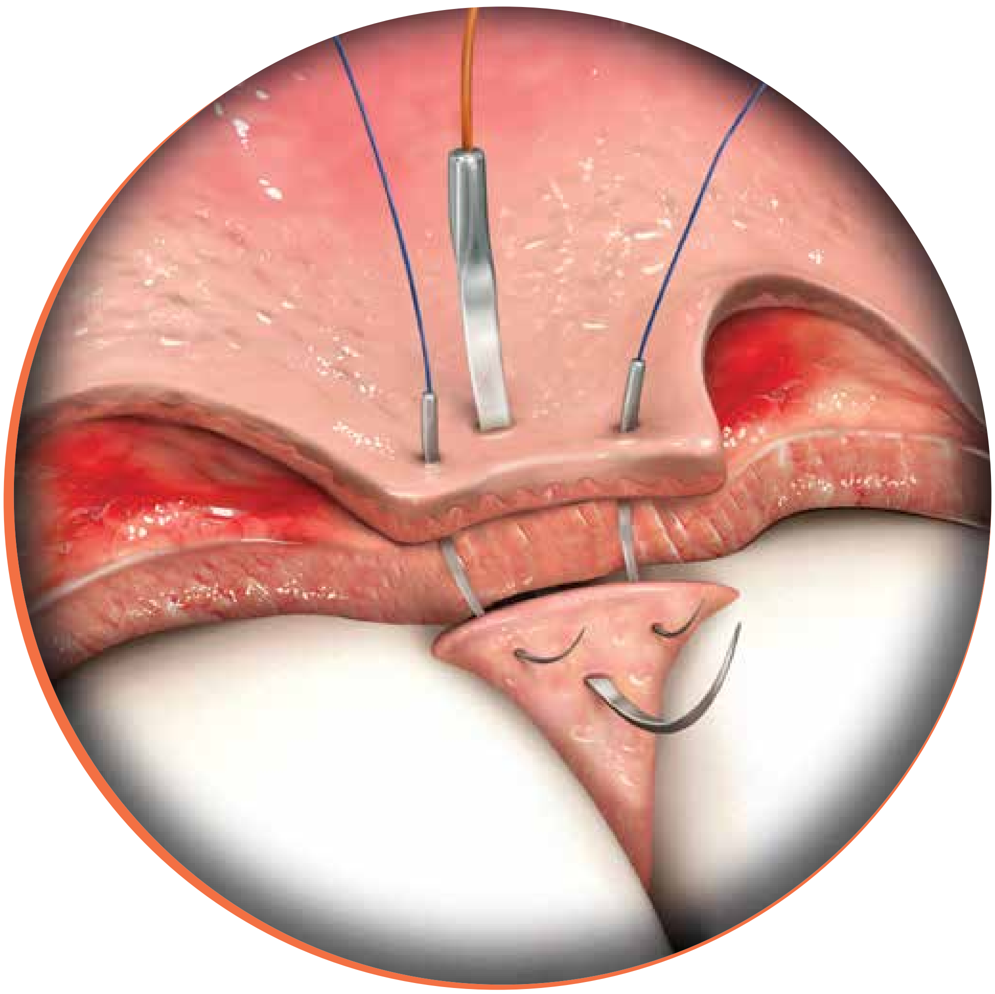
Glécio Vaz de Campos, DDS   Cláudio Julio Lopes, DDS



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Tribute to Dr Dennis Shanelec

The father of periodontal microsurgery

In the last week before finishing this book, we received the news that Dr Shanelec had passed away. The thrill in concluding this work was dampened by the shock of the interruption of Dr Shanelec's brilliant journey. I had few personal contacts with him, but they were very intense. The first one was in 1996, when I attended his microsurgery course at the Microsurgery Training Institute in Santa Barbara, California. It changed my career and my personal life because it enabled me to tread a new path and seek for new horizons. The second personal contact was in Huntington Beach, California, at the AMED (Academy of Microscope Enhanced Dentistry) annual meeting. Surprisingly, right after my lecture, Dr Shanelec was waiting for me on the pulpit steps, where he congratulated me on my speech. So I thanked him, saying that the presentation was the fruit of the microsurgical principles he had taught me. His generosity in saying that I had already raised the bar stayed forever in my memory. Dr Shanelec's words were very striking and a great stimulus for the development of this book. Thank you, Dr Shanelec, for your knowledge and, above all, for your wisdom, which completely changed people and the world of periodontics.

–Glécio Vaz de Campos

Dr Dennis Shanelec was undoubtedly a milestone in the contemporary dentistry scene, both in periodontics and in implantology. As a master, he left us an invaluable legacy of technical and philosophical innovations in the field of periodontal and peri-implant plastic microsurgery, hitherto never achieved. I had the honor and privilege of receiving many of his teachings through some of his best disciples, now seeds scattered throughout the world. As a great human being, he left us inspiring records of kindness, compassion, and humility—an example to be followed by the next generations.

–Cláudio Julio Lopes

Contents

Foreword

It is with a mixture of pride and satisfaction that I received the invitation of Glécio Vaz de Campos to preface this magnificent work—his legacy. There are several meanings to the word *legacy*. Among them, for example, is knowledge passed on to the next generations or something transmitted or acquired that is left for a whole and not just for one.

The path traveled was long and arduous, but Glécio is undoubtedly a visionary. The visionary is one who has the rare ability to combine vision with competence. He does not see only the present; he also sees the future. He can predict trends and anticipate changes rather than simply being hit by them. Looking at it today, that's precisely it. The story of this journey begins in 1995, during the annual congress of the American Academy of Periodontology. After attending this conference and then attending an immersion course taught by Professor Shanelec in Santa Barbara, California, the time had come to introduce periodontal plastic microsurgery in Brazil. This was 24 years ago.

Glécio set up the first laboratory for developing the skills required to perform microsurgical procedures in his private clinic, having already trained many professionals from Brazil and abroad. But still that was not enough. More was needed. Knowledge needed to be diffused, not just kept in the mind of a brilliant surgeon. His courses on periodontal plastic surgery were brought to the São Paulo Dental Association, where he now supervises a multidisciplinary microsurgery laboratory. Since then, Glécio has delivered countless microsurgery-related courses and lectures and published several book chapters and articles. But still he wanted to demonstrate the importance of periodontal and peri-implant plastic microsurgery and present a step-by-step method, from laboratory to daily clinical practice, safely and predictably. Hence what you are now holding in your hands.

This book, distributed in nine carefully written and logically sequenced chapters, is intended to serve not as a manual but as a practical guide. The reader is first taught the fundamentals of microsurgery and from there can develop the skills through laboratory training where ergonomics and magnification are emphasized. Further on, the main techniques of periodontal plastic microsurgery are didactically presented. This beautiful work is undeniably a gift to dental professionals.

To paraphrase the enologist Luís Henrique Zanini, "A vineyard requires sensitivity; it takes humanity. Masters and doctorates are of no use if we lose our identity. It takes physical contact with the vineyards, with the grape; you literally have to get your hands on the wine." Likewise, to be an educator and an excellent periodontal surgeon, you need sensitivity. Masters and PhDs are no good. We have to literally lay our hands on it. And this is Glécio's gift and legacy to us.

Sérgio Kahn, DDS, MSc, PhD
President of the Brazilian Society of Periodontology

Foreword

It's a true honor and privilege to write a foreword for this significant new textbook full of valuable information and new perspectives in the field of dental microsurgery. The book is a true landmark in clinical dentistry and is carefully presented by Drs Glécio Vaz de Campos and Cláudio Julio Lopes and their coauthors, incorporating the key fundamentals and clinical steps in periodontal and peri-implant plastic microsurgery. The written content comprehensively presents the scientific evidence and clinical relevance in the ever-growing field of microsurgery, with many beautifully illustrated photographs and diagrams. The book clearly showcases that dentistry is swiftly moving toward minimally invasive treatment in the nonsurgical and surgical fields, and critical key points and important elements like magnification, microinstruments, and minimally invasive techniques have become the new gold standard of high-quality dentistry.

Specialists, general practitioners, and dental students interested in cutting-edge science and surgical treatment will be able to understand and embrace the new directions of minimally invasive surgery for the benefit of patient comfort and long-term results and will be able to incorporate the essential steps of this new discipline in their office.

The authors show that discipline, focus, and early passion for their field have moved them from students to mentors and leaders. I believe that many new students will have the same potential if they put forward a similar effort and dedication to this exciting field of microsurgery. Thank you, Dr Glécio and Dr Cláudio, for your dedication to enhance our understanding of microsurgery—your textbook will surely reach the level of a true standard.

Sascha A. Jovanovic, DDS, MS
Chairman, gIDE Institute

Preface

Periodontal and peri-implant plastic microsurgery have become particularly valuable in periodontics and implantology because of the potential for primary intention healing. This is related to the development of precise surgical techniques, gentle tissue manipulation, patient well-being, fast healing, and predictable outcomes.

Our decision to start this book 3 years ago was based on 24 years of dedication to develop a minimally invasive surgical philosophy and the accumulation of decades of clinical experience. Moreover, in recent years, the periodontal literature has gradually demonstrated with scientific evidence the importance of microsurgical principles. Further, there have been no studies contradicting this value or showing any possible detriment to the practitioner or patient when following this philosophy. We hope that more and more comparative clinical studies will contribute to the scientific consolidation of periodontal microsurgery, just like what has happened in medical specialties.

In this book, we sought to offer content that included the minimally invasive philosophy, the protocols for the development of new skills for the surgeon, the systematization of microsurgical techniques, the solutions for soft tissue defects, and the correlation of these microsurgical principles with implantology. We also wanted to address digital planning and microsurgery for clinical crown augmentation for esthetic purposes as well as proper ergonomics for surgeons who use magnification, which is crucial for their health, comfort, and quality of life.

Particular highlights of the writing process included presenting the principles that direct periodontal and peri-implant microsurgical techniques as well as guiding those interested in a safe pathway to their first microsurgery. Our goal was to stimulate discussion of the advantages and disadvantages of microsurgery as well as to encourage the development of increasingly conservative, biologic, and predictable procedures.

This book is intended for *all* professionals (beginners or experienced) seeking a minimally invasive surgical philosophy with a focus on respecting biologic principles, preserving healthy tissues, enhancing patient well-being, and achieving satisfaction with the esthetic results of soft tissues. Happy reading!

Acknowledgments

From Glécio Vaz de Campos

To my coauthor, Dr Cláudio Julio Lopes, I would like to thank you for your partnership and for your indispensable organization, seriousness, and persistence in developing and completing this book. Your ability to conceptualize the minimally invasive philosophy in illustrations catalyzed and enhanced the publisher's graphic arts work. Your long experience, competence, and fidelity to microsurgical principles were decisive in the collaboration of the text and in the revision of the chapters. Coupled with all this, my family and I have made sure that, besides being a brilliant periodontal microsurgeon, you are a great friend!

To Dr Fátima Tonello Vaz de Campos, my wife, I make a point of recording your direct participation in the writing of this book. You selected and organized the clinical cases, edited the videos, were creative in naming techniques, and were especially encouraging in the most challenging times. Your good humor, creativity, and intelligence inspired us and guided us through obstacles.

Many thanks to my dear children, Alexandre and Marcelo, and my daughters-in-law, Ludmila and Cyntia, for your constant encouragement. To my mother, Marlene, for the joy of your conviviality. I miss (in memoriam) my father, Dr Alfredo, for the continual example of life, and my eternal brother, Dr Márcio, whom we miss so very much. Moreover, I thank God indeed for the arrival of Felipe, my first grandson.

I also thank the Minimally Invasive Dentistry team—Cristiane Bissoli, Luciane Bardela Cavalaro, and Hélen Elisa Pessoto—for your competence, dedication, and friendship.

To the Napoleão Publishing House/Quintessence Publishing in Brazil, particularly directors Guilherme and Leonardo Napoleão, and the team, I thank you for the opportunity to develop this creative work without restrictions and, above all, for the stimulus to surpass our limits.

From Cláudio Julio Lopes

To Dr Glécio Vaz de Campos, my sincere thanks for the invitation and the privilege of being able to participate as coauthor to this brilliant project. Throughout our 2-year journey of hard work, I have had the opportunity to live and learn from this great human being and professional who guides his life on discipline, organization, and seriousness, essential qualities for those who embrace microsurgery as a philosophy of work. I appreciate your patience, respect, friendship, and generosity throughout the writing of this book.

To Dr Fátima Tonello Vaz de Campos, for her essential participation in all stages of the preparation of this work. I thank you for all your kindness, professionalism, joy, common sense, and friendship, which were fundamental for us to reach the end of our work.

To my partner, Mauricio de Melo Lacerda, for the unflagging patience, encouragement, and collaboration over the last few years that have been instrumental in this process.

To my dear parents, Antonio and Lucilia, brothers, and family for the affection and encouragement always present.

To the entire Microdent team for their understanding and availability during the writing of this book.

To my friend Josias Silva for his collaboration and excellent work in the photographic documentation of clinical cases of clinical crown augmentation.

To the Napoleão Publishing House/Quintessence Publishing in Brazil, particularly directors Guilherme and Leonardo Napoleão, for the opportunity to make this dream come true. Thank you for the patience, support, and talent of the entire team.

To Quintessence Publishing Chicago, specifically William G. Hartman, our sincere gratitude for believing in the content of our work. And to Leah Huffman and Sarah Minor for the fancy editorial work and production that brightly enhanced the book's final outcome.

"Life is not about goals, achievements and finish lines … it's about who you become along the way." —*Gisele Ferreira*

About the Authors

Glécio Vaz de Campos, DDS, received his DDS degree from the Universidade Estadual Paulista (UNESP) in Araraquara, Brazil, in 1982. After he specialized in periodontics and prosthetics, several years of clinical practice led him to explore new techniques focusing on periodontal plastic surgery. In 1996, he was qualified on this subject at the Microsurgery Training Institute in Santa Barbara, California. He had a significant role in introducing periodontal and peri-implant plastic microsurgery techniques to Brazil and expanding the use of the operative microscope there. From 2000 to 2004, Dr Campos served as Director of the Operative Microscopy Department at the São Paulo Dental Association (APCD), where he organized the largest training facility on operative microscopy in South America. Dr Campos has coauthored 16 books related to periodontal and peri-implant plastic microsurgery, as well as scientific articles published in Brazil and abroad. Currently he maintains private practices in Jundiaí and São Paulo, Brazil, where he focuses on periodontal and peri-implant plastic microsurgery and offers regular training courses in his private microscopy laboratory in Jundiaí.

Cláudio Julio Lopes, DDS, received his DDS degree from São Paulo City University in 1989. After specializing in periodontics, he became an assistant professor of periodontics at Camilo Castelo Branco University in São Paulo, Brazil, where he stayed from 1990 to 2000. He then moved on to become coordinator of the Periodontal Plastic Surgery and the Introduction to Microsurgery courses at the São Paulo Dental Association (APCD), which he continued until 2015. In 2014, he specialized in implantology with the Brazilian Dental Association (ABO), and in 2017, he qualified in reconstructive microsurgery at the Institute of Orthopedics and Traumatology at the University of São Paulo. He maintains a private practice in São Paulo, Brazil.

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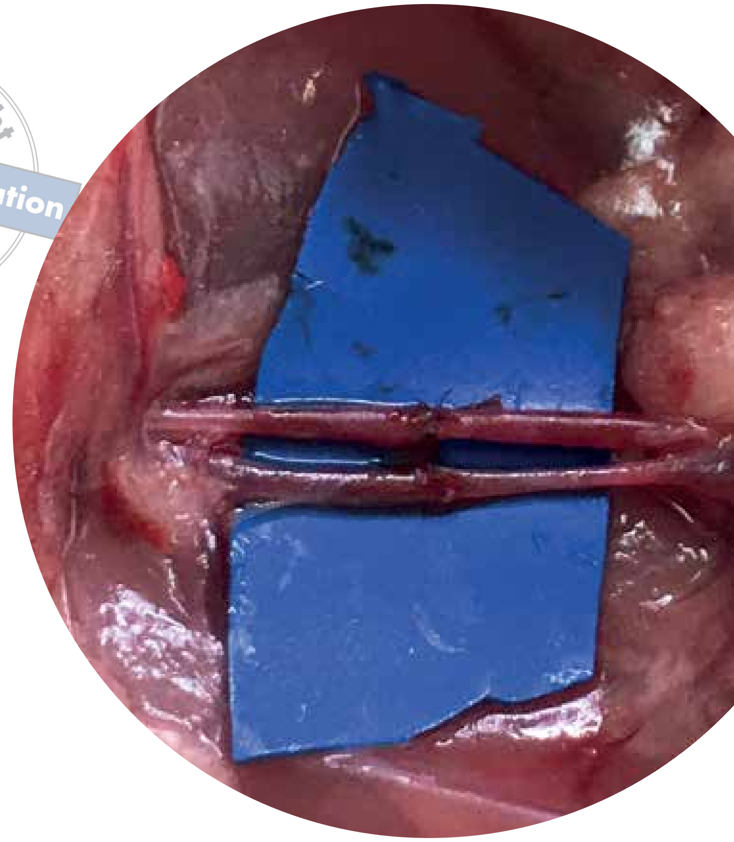
Minimally Invasive Surgery



Clinical outcomes are enhanced when the most accurate surgical approaches are performed using magnification systems, precise instruments, and microsurgical materials.

Reconstructive Vascular Microsurgery

Microsurgical techniques have a long history, but the broad application of vascular microsurgery in different medical specialties is a relatively recent phenomenon. The history of microsurgery is directly related to the development of optical magnification of the operatory field and the refinement of microinstruments.[1]

The first techniques to use the microscope were developed for research purposes. Carrel's work on vascularized organ transplantation in 1902 seems to be the first record of the application of microsurgical techniques.[2] Otorhinolaryngology was the first specialty to consider the benefits of microsurgery, and eye and ear microsurgery led to the development of more sophisticated operative microscopes, equipment, and techniques.

Jacobson et al were the first to publish on the use of microsurgery for small blood vessel anastomosis,[3] and since then the use of magnifying glasses and microscopes has grown and developed widely. Today, more complicated procedures are possible both in animal models and clinically in patients. The most advanced techniques are initially developed and trained in animal models and then transferred to clinical use. Magnifying loupes are used for lower magnification levels (2× to 8×), while operative microscopes work at 9× to 40× magnification.

Otorhinolaryngology was the first specialty to consider the benefits of microsurgery.

Microsurgery did not develop as a subspecialty of medicine. On the contrary, microsurgical techniques have been incorporated by a wide variety of specialties, such as pediatric surgery, neurosurgery, plastic surgery, and vascular surgery, being an essential element in the outcome of many surgeries and treatments.[4]

Learning microvascular techniques in the microsurgery laboratory is the first step for surgeons who wish to adhere to this treatment philosophy. Successful training in microvascular techniques requires excellent concentration and persistence, which may lead to frustration at first. The training environment should be calm and preferably without distractions of any kind. In order to maximize training and lessen the physiologic tremor that almost everyone experiences to some degree, appendicular muscle impact exercises, caffeine, and nicotine should be avoided 24 hours before any training. Also, the activity should be interrupted for 5 minutes every hour of training in order to reduce fatigue.

The instruments used for microvascular anastomosis include jeweler's micro pliers, microscissors, microclips, a 10-mL syringe with 90-degree angled blunt insulin needle, clip holder, no. 11 scalpel, retractors, and monofilament sutures. The suture size should be 11-0 for vessels with 0.5-mm diameter, 10-0 for vessels with 1-mm diameter, and 9-0 for vessels with 2-mm diameter.

Surgeons must know how to work the operative microscope lens system and should opt for the appropriate magnification for the work to be performed. Binocular vision and work in the center of the field are also crucial for proper technique.

Once microsurgery trainees know the technical environment, they can begin to acquire and develop the skills for the microsuture technique. Initially, the training for this technique is practiced on nonanimal models prepared especially for this procedure. Suturing a rubber model is a training step that precedes suturing living and delicate structures and uses a wooden board with a hollow center covered with a rubber or latex strip. Several cuts in different shapes and sizes should be made in the rubber strip to simulate the edges of the structures that will be sutured, offering varying degrees of difficulty.[5,6]

Microsutures are made by following some basic concepts. The point of entry of the needle must be perpendicular to the entry plane; otherwise, the edge will be inverted. The distance from its entry to the edge should be three times the diameter of the needle. If this distance is not respected, the edges will overlap. The needle exit on the other side should also be perpendicular to the cut in the rubber. As the surgeon's confidence and skill improve, the diameter of the suture should decrease, and the microscope should be zoomed in progressively.[5,6]

Following initial training on rubber models, practice should begin on animal models. Wistar rats are the ideal animals to practice vascular microsurgical techniques in the laboratory. The rats have a suitable vascular network with many easily accessible vessels and nerves of appropriate gauge for different types of sutures. As a basis for comparison, a 300-g rat, considered the ideal size, has a 1-mm-diameter femoral artery, a 2-mm aorta, and a 1.5-mm carotid artery. The anesthetic techniques must provide an adequate chemical containment, hypnosis, and analgesia for pain to allow for a fast and smooth recovery from the anesthesia.

The most favorable areas for training in a rat model are the inguinal region (femoral artery and vein) and the cervical region (carotid artery and jugular vein). The most commonly used techniques are end-to-end and end-to-side anastomosis. After preparation and proper anesthesia of the animal, delicate subcutaneous dissection is performed, and retractors are placed on the incision margins. The vessels used in training are identified and dissected with the microscissors, individualizing them. The difference between arteries and veins is observed by three main characteristics: arteries cross over veins, have a smaller gauge, and have a thicker vascular wall. Despite the smaller size, the arteries offer easier manipulation and have more resistant walls. For this reason, they are the vessel

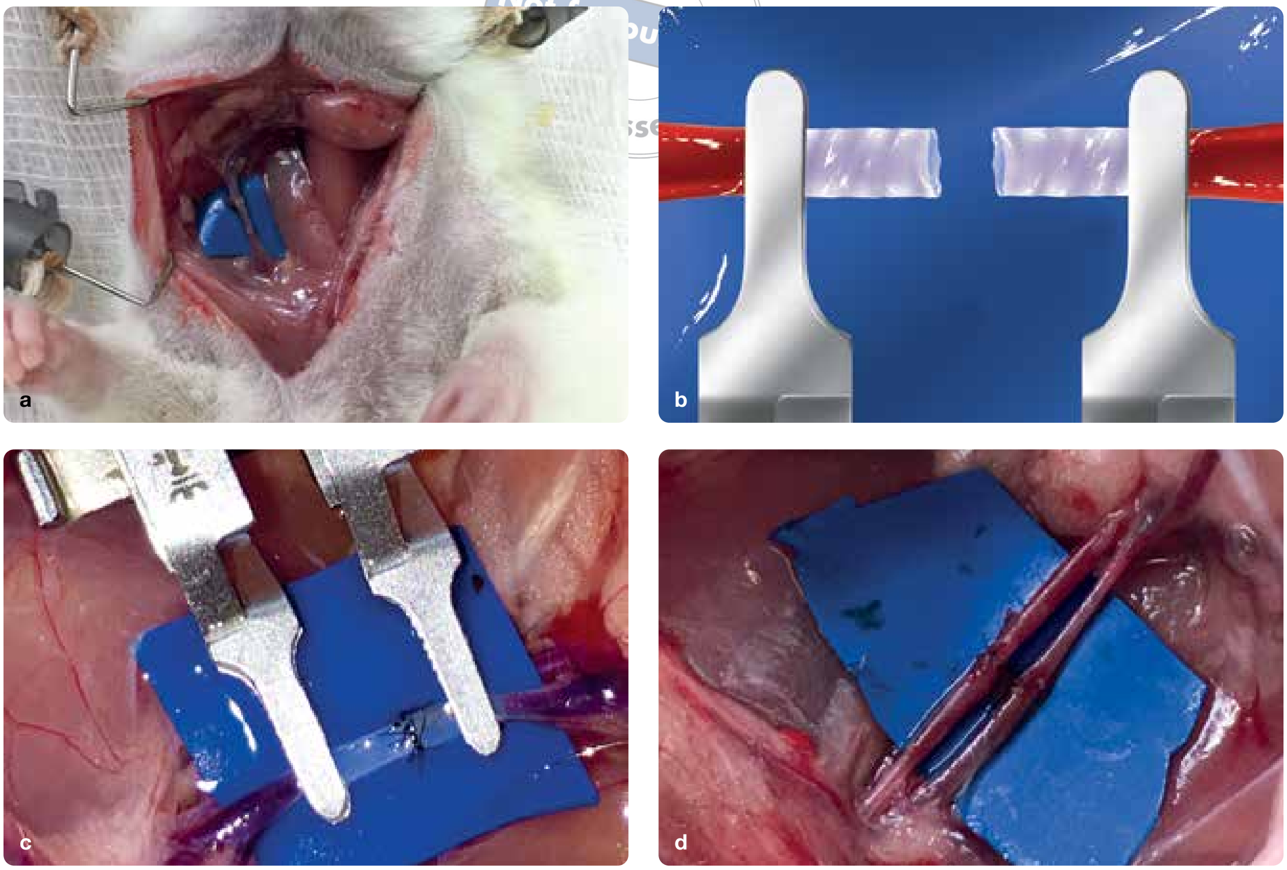


Fig 1-1 *(a)* Wistar rat prepared for laboratory training of microvascular anastomosis. *(b)* Microclip with the two stumps of the vessel stabilized for the first microsutures at positions 6 and 12 o'clock. *(c)* Exercise of microvascular anastomosis in the femoral artery finalized before removal of microclip. *(d)* The finalized femoral artery and vein microvascular anastomoses after microclip removal. Observe hemostasis achieved after microsutures.

of choice for initiating microvascular anastomosis training. Handling should be minimal to avoid spasm and injury to the vascular wall, and the vessel's outermost coat (ie, tunica adventitia) should be used to mobilize it (Fig 1-1a).

To begin the microvascular anastomosis technique, the distal and proximal microclips are placed, followed by a complete transverse incision of the vessel using microscissors. Heparinized saline solution is used to irrigate the interior of the vessel in both stumps. The anastomosis is performed with the first two sutures placed on the upper and lower poles at 12 o'clock and 6 o'clock, respectively (Fig 1-1b). A long suture termination is left for later traction in order to visualize the position of the vessel edges and obtain a symmetric suture. The next suture sites to be performed with single stitches are those corresponding to 9 o'clock, 7:30, and 10:30 (eg, the posterior wall of the vessel). In order to achieve this, the clips are rotated 10 degrees to expose this wall. The next step is to undo the rotation of the vessel and suture its anterior wall with simple stitches at 3 o'clock, 1:30, and 4:30 (Fig 1-1c). Finally, the microclips are removed, and the region of the vessel with blood inside is drained toward the anastomosis. At this point, the patency of the vessel and the possible leakage of blood through the suture points can be verified[4–6] (Fig 1-1d).

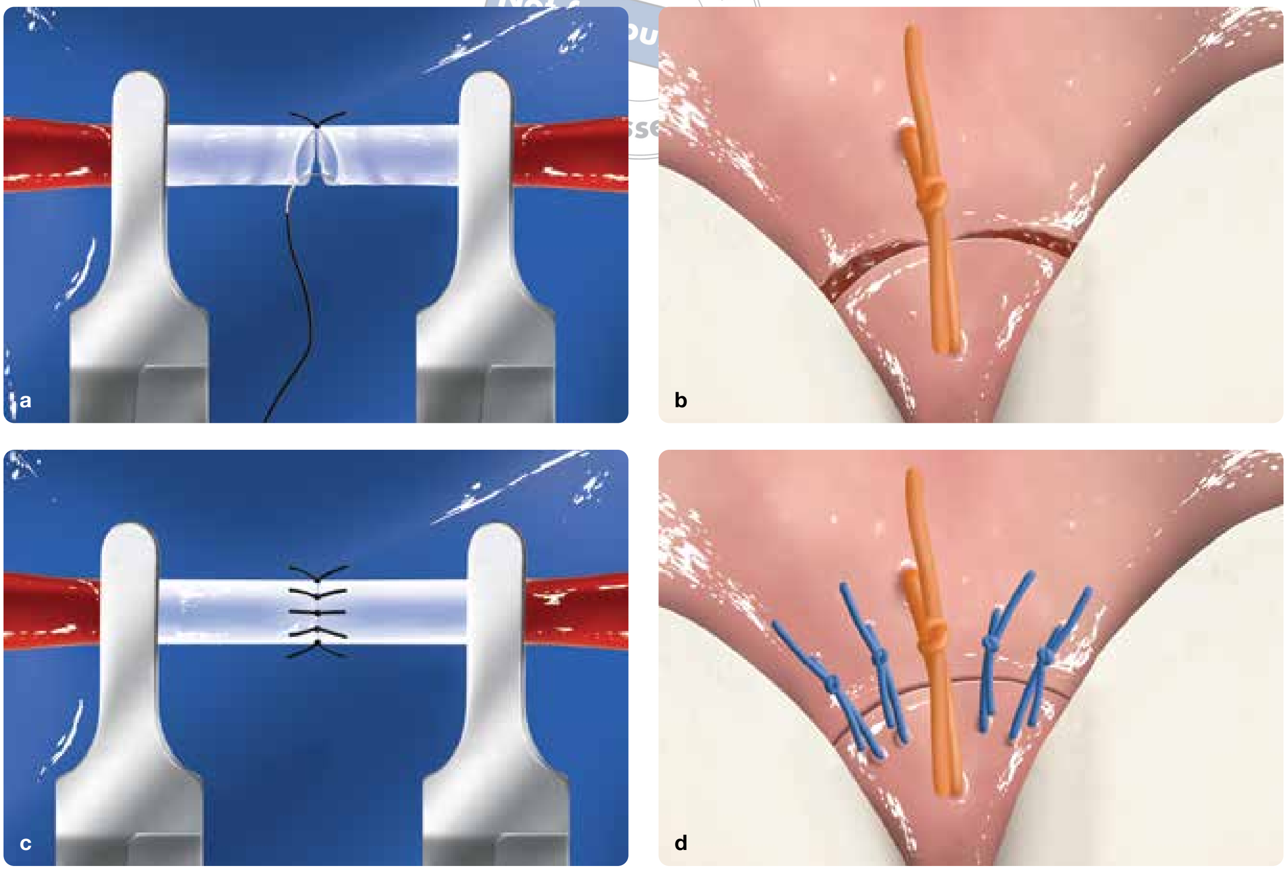


Fig 1-2 Correlation between vascular microsurgery and periodontal plastic microsurgery. *(a)* The microclip approximates the stumps of the vessel to be sutured. *(b)* The microsutures eliminate flap tension. *(c)* Finished vascular microsutures. *(d)* Coaptation of wound edges.

Microsurgical principles already developed in medical specialties were initially applied in periodontal plastic surgery by Dennis Shanelec.[7,8] His great achievement was to establish philosophic and biologic analogies between the foundations of microsurgery already established in medicine and the characteristics of periodontal soft tissues. Initial perpendicular papillae microincisions, uniform flap thickness, and the geometry of the microsuture were developed with the goal of primary wound closure to achieve primary intention healing (Fig 1-2). This way, the development of the periodontal microsurgical approach was accelerated, and it allowed for the establishment of a protocol focused on the solution of soft tissue defects.[7–13]

Surgical Wound Healing

Primary wound closure is critical to the success of microsurgery. In periodontal and peri-implant plastic microsurgery, survival and integration of subepithelial connective tissue grafts (SCTGs) depend on several factors, including the quality of blood supply to the involved tissues and the prevention of bacterial infection. Primary wound closure over an SCTG prevents entry and proliferation of microorganisms.[14]

Healing after periodontal/peri-implant microsurgical procedures is challenging as the surgical wound is located on a rigid, avascular surface of the tooth (or implant), resulting in decreased local immune defenses and nutrients to the tissues involved. Difficult healing may lead to wound dehiscence, soft tissue defects, or scarring and may adversely affect the esthetic outcome.

The term *wound healing* involves the entire physiologic regenerative process responsible for restoring the integrity of damaged tissues. Because surgical wounds are created in a controlled environment, the surgeon has great power over many factors involved in the healing process from incision to closure.

Primary wound closure over an SCTG prevents entry and proliferation of microorganisms.

Principles of Healing

Tissue response to injury

Wound healing occurs by one of two mechanisms: regeneration or repair. *Wound regeneration* refers to the replacement of lost or damaged tissue with identical tissue, resulting in the restoration of the tissue to its original condition. *Repair*, on the other hand, involves replacing the lost or damaged tissue with unspecific scar tissue and is therefore not restored to its original condition.

In surgical wounds, the surgeon should strive to achieve full regeneration (regenerative healing) of the injured tissues and to prevent the formation of extensive scar tissue. The state of the wound closure determines the restorative healing during the healing process. When a wound is left open, a repair tissue is formed to cover the defect and restore its superficial integrity. This newly formed repair tissue becomes scar tissue during the later stages of healing.

In surgical wounds, the surgeon should strive to achieve full regeneration (regenerative healing) of the injured tissues and to prevent the formation of extensive scar tissue.

In general, primary wound closure results in primary intention healing, and open wounds result in secondary intention healing. From a biologic point of view, the ultimate goal of wound healing by primary or secondary intention is the same: wound closure. However, the two processes differ in the chronology at different stages of wound healing and in the quality of the tissues formed during the healing process.[14,15]

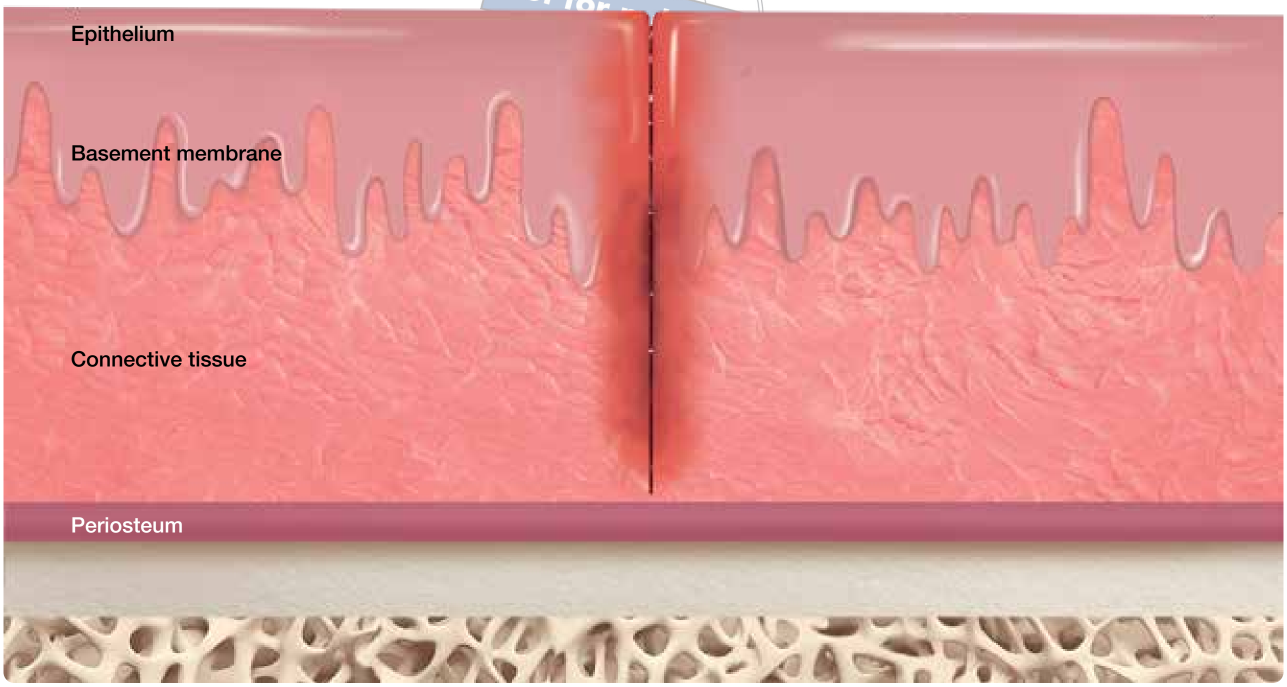


Fig 1-3 The primary intention healing pattern obtained when using incisions perpendicular to the tissue surface and when butt-joint coaptation of the wound is done.

Primary intention healing

Primary intention healing is a type of surgical wound repair that results from well-defined incisions and sutures performed through the butt-joint approach (Fig 1-3). Precise incisions cause the death of a limited number of epithelial and connective tissue cells, as well as reduced rupture of the epithelial basal membrane.[9,10] This type of healing presents rapid wound closure with little or no scar tissue formation. In other words, the tissue becomes intact and similar to its original condition. From a surgical point of view, wounds with uniform borders that are well vascularized, without tension, and precisely approximated present the most favorable conditions for primary intention healing. After primary wound closure, a thin, stable blood clot forms between the wound edges without local ischemia in the tissue. This technique makes it difficult for bacteria to enter the wound, particularly in the deeper layers of the tissue. Blood circulation restores rapidly, and a temporary matrix is formed to protect the area. Under favorable conditions, primary intention healing will occur within a few days in the absence of clinically detectable inflammation, secretion, or formation of granulation tissue.

Whenever possible, the surgeon should create the right conditions for primary intention healing, which usually ensures a faster and uneventful postoperative period. Thus, the acute inflammatory response that invariably occurs during the healing process will be short and almost clinically imperceptible. Also, the patient will experience less discomfort, fewer limitations, and no necrosis-related tissue defects during the postoperative period. The tissue regeneration process

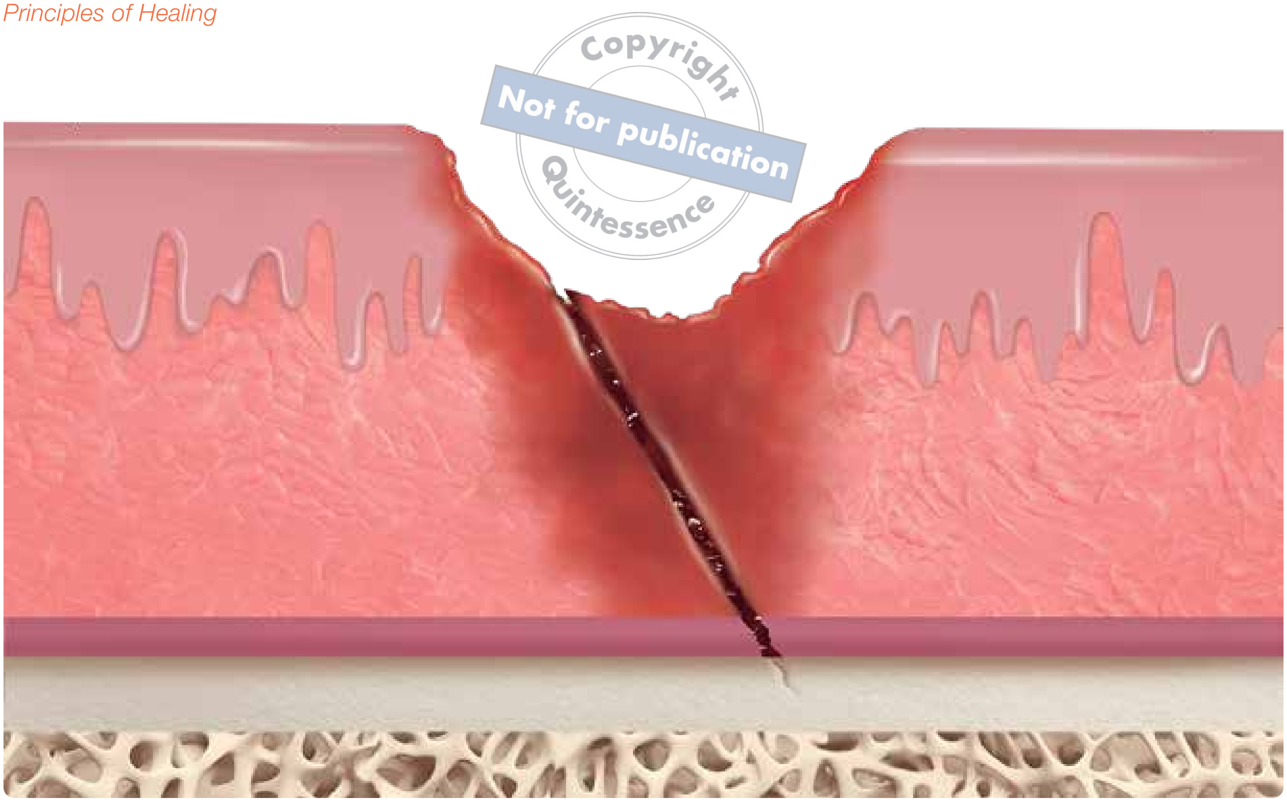


Fig 1-4 This pattern of secondary intention healing is typical when using beveled incisions. This type of incision generates areas of epithelial tissue without connective tissue support, favoring necrosis.

proceeds under the wound surface, and healing will result in repair of the original condition with little chance of scarring.

Secondary intention healing

Secondary intention healing occurs when the edges of the wound are intentionally pushed back, or if primary wound closure was not possible due to tissue defects (Fig 1-4). In this type of healing, the loss of cells and tissue is more extensive, and the repair process becomes more complicated.[16] Secondary intention healing is associated with the formation of repair tissue. In order to quickly cover the wound and restore the integrity of the oral cavity epithelial lining, the body produces poor-quality scar tissue that fills the gap caused by the injury or the lack of tissue. Areas of necrosis at the edges of the flap are often observed if the sutures exert too much tension, if they are not well performed, or if they are loose (see Fig 1-8). Even when achieving primary wound closure, there will be healing by secondary intention if there are areas with inadequate blood supply. A scar will remain after the final repair process, and the texture and color of this tissue may differ significantly from the adjacent tissues.

Secondary intention healing is associated with an increased risk of bacterial infection, postoperative discomfort, and scar tissue formation.

Secondary intention healing is associated with an increased risk of bacterial infection, postoperative discomfort, and scar tissue formation. Therefore, whenever possible, it should be avoided, especially for surgery in esthetic areas.[9–11]

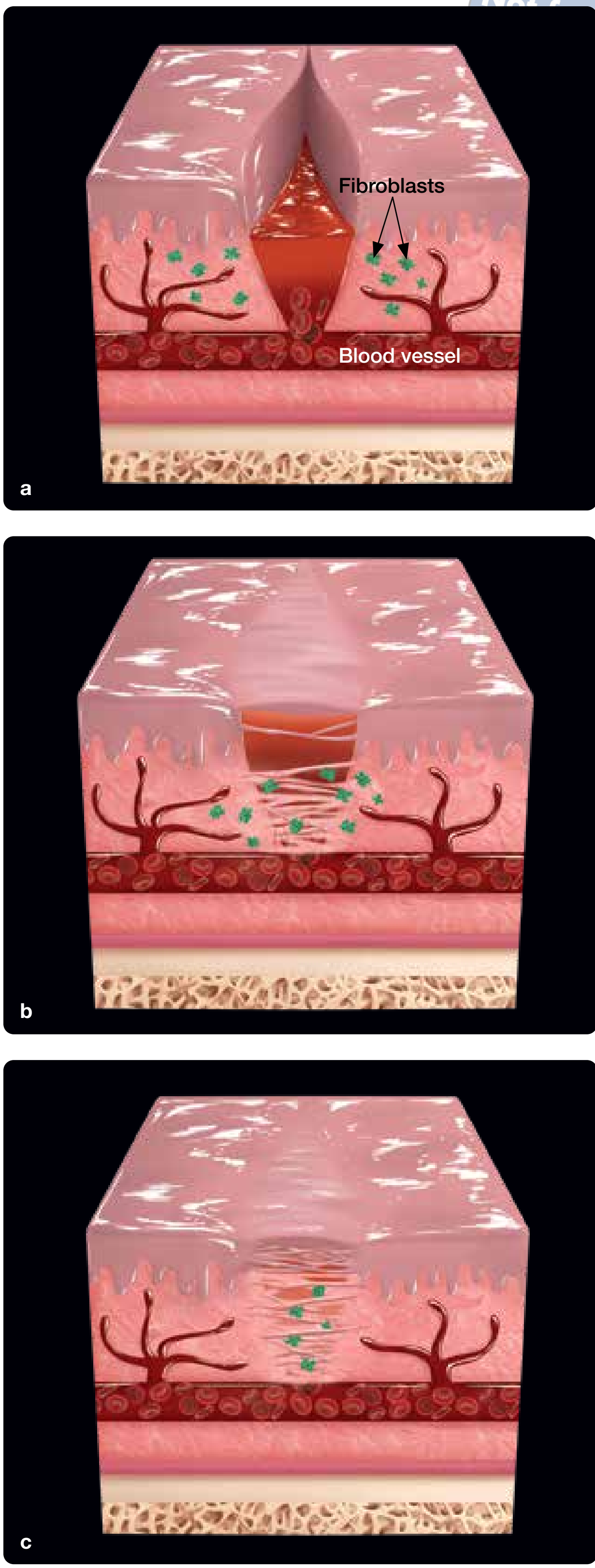


Fig 1-5 Phases of wound healing. *(a)* Phase 1: Inflammatory response (1st to 5th day). *(b)* Phase 2: Migration/proliferation (5th to 14th day). *(c)* Phase 3: Maturation/remodeling (14th day until final healing). (Schemes adapted for periodontal tissues.[17])

Phases of Wound Healing

The wound healing process involves all physiologic regenerative processes initiated by the body in order to restore the continuity of its tissues.[14–17] The interactions between mesenchymal and epithelial cells, mediated and coordinated by a large number of chemical mediators with local and systemic effects (growth factors and cytokines), play an essential role. The general wound healing process has three evolutionary phases that overlap over time: the inflammatory phase, the proliferative phase, and the maturation phase (Fig 1-5). These phenomena illustrate the general principles that apply to all tissues, including periodontal tissues, but with different duration times for each event. The sequence of the healing process of the human skin is described below.

Phase 1: Inflammatory response (1st to 5th day)

Fluids containing plasma proteins, blood cells, fibrin, and antibodies migrate to the wound site. A crust forms on the surface to seal the scarring fluids and prevent bacterial invasion. Inflammation, which results from leukocyte migration to the region, occurs within a few hours, causing localized swelling, pain, heat, and redness at the wound site. Leukocytes rupture to remove cellular debris, phagocyte microorganisms, and foreign bodies. Bone marrow monocytes that then reach the wound site become macrophages to phagocytose residual cellular material and produce proteolytic enzymes. Finally, basal cells at the epithelial margins migrate over the incision to close the wound surface. Simultaneously, fibroblasts located in deep connective tissue initiate reconstruction of nonepithelized tissue. During the acute inflammatory phase (see Fig 1-5a), the tissue does not acquire high tensile strength, depending solely on the closure material (suture) to maintain its position.

Phase 2: Migration/proliferation (5th to 14th day)

During the first or second week after surgery, fibroblasts (precursor cells of fibrous tissue) migrate toward the wound area. With enzymes from the blood and surrounding tissue cells, fibroblasts synthesize collagen and basal substances (eg, fibrin and fibronectin). These substances attach fibroblasts to the substrate. Fibroblasts contain myofibroblasts that have smooth muscle characteristics and contribute to wound contraction. Collagen deposition begins approximately on the 5th day and rapidly increases the tensile stress of the wound. Plasma proteins assist in cellular activities, which are essential in the synthesis of fibrous tissue during this healing phase. In addition to collagen synthesis, other compromised connective tissue components are replaced. The lymphatic network recovers, vascular neoformation occurs, granulation tissue forms, and many capillaries develop to nourish the fibroblasts (see Fig 1-5b). Almost all of these structures disappear during the final healing phase.

Phase 3: Maturation/remodeling (14th day until the end of the healing process)

There is no precise distinction between phases 2 and 3. Healing begins rapidly during phase 2, then decreases progressively. Tensile strength continues to increase up to 1 year postoperatively. The skin recovers 70% to 90% of its original tensile strength. Deposition of fibrous connective tissue results in scarring. In a regular healing pattern, the contraction of the wound occurs over weeks and months. As collagen density increases, blood vessel formation decreases and scar tissue increases, with a pale appearance (see Fig 1-5c).

Surgical Principles That Interfere with Healing

The surgical team controls many factors that directly affect the healing process. The top priority should always be to maintain an aseptic and sterile technique to prevent any infection. While there are microorganisms that are part of the patient's oral microbiota that can be responsible for postoperative infections, the microorganisms from the surgical team also pose a threat. Regardless of origin, the infection will always prevent healing.[4] When planning and conducting a surgical procedure, surgeons should consider the following sterilization issues.[17]

The top priority should always be to maintain an aseptic and sterile technique to prevent any infection.

Length and direction of the incision

The adequately planned incision should be long enough to allow appropriate access to the operative field with optimal exposure to the area. The direction of the incision should always be at a 90-degree angle to the tissue surface.

Split-thickness flap technique

The division of the flap should be performed in successive layers to obtain a flap of uniform thickness. The surgeon should preserve the integrity of the underlying tissues as much as possible (ie, nerves, blood vessels, muscles, etc).

Gentle tissue handling

The smaller the trauma to the tissues, the faster the healing will be. The tissues should be carefully manipulated during the surgical procedure, and tissue retractors should be used with caution to avoid excessive pressure, as tension on tissues can cause compromised blood flow and alter the physiologic healing process.

Hemostasis

Various mechanical, thermal, and chemical methods can be used to control blood and fluid flow to the surgical wound. Hemostasis allows the surgeon to work in a clear field with greater precision. Without proper control, bleeding from incised tissues can interfere with visualization of underlying tissues. Excellent hemostasis before wound closure will prevent the formation of postoperative bruising. Incision hematoma may prevent primary wound closure. Also, the accumulation of blood or fluid in this region provides the formation of an ideal culture medium for bacterial growth and the consequent risk of infection. Conversely, suturing maneuvers in extensive surgical wounds should be performed in a controlled and gentle manner to avoid necrosis and prolonged healing periods.

Tissue hydration

During surgical procedures, the surgical area should be periodically irrigated with saline solution to prevent the tissues from dehydrating.

Choice of suture materials

The ideal type of suture allows the surgeon to approach the tissues with as little trauma as possible and as accurately as possible to eliminate open spaces. The surgeon's personal preference plays a decisive role in choosing the suture material, but the location of the wound and the factors inherent in the patient must also influence this decision.

Tissue response to suture materials

Whenever placing a foreign material inside the tissues, a reaction will occur. This reaction will range from minimal to moderate, depending on the type of material implanted in the tissues. The reaction will be more intense if there are any complications such as infection, allergy, or trauma. After suture completion, adjacent tissue edema begins, and its intensity is related to surgeon care.

Eliminating open spaces within the wound is critical to the healing process.

Elimination of open spaces within the wound

Eliminating open spaces within the wound is critical to the healing process. Open spaces within the wound are a result of poor coapting of the edges of the tissue. Accumulation of blood or fluid within tissues may provide an ideal culture medium for bacterial colonization with subsequent infection. At the end of the surgery, compression maneuvers should be used to eliminate excess accumulated blood and establish a fine clot in the surgical wound.

Sutures with the appropriate tension

In the same way that only adequate tension should be used to bring tissues closer and eliminate voids, sutures should be passive enough to prevent patient discomfort, ischemia, and tissue necrosis during the healing.

Postoperative wound trauma

Postoperative patient activity may induce trauma to the surgical wound. Surgeons should make sure that the closure of the wound is stable enough to prevent suture dehiscence during the healing period.

In conclusion, surgeons should prevent anything that can negatively influence or be detrimental to the healing process, while favoring the occurrence of primary intention healing phenomena.

Factors That Influence Healing

Several local and systemic factors may influence the primary intention healing of surgical wounds (see Boxes 1-1 and 1-2).[14] Achieving primary wound closure is critical to the success of periodontal and peri-implant plastic surgery.

Local factors

Box 1-1 outlines the local factors that may influence wound healing. These are discussed in the sections that follow.

Lack of inflammation

Gingival inflammation negatively affects the quality of periodontal and peri-implant soft tissues. As a result of the inflammatory process, there is a decrease in collagen content and a significant increase in blood flow, interstitial fluid, and soft tissue inflammatory cells. In addition to impairing wound healing, it also causes transoperative technical problems. In the presence of inflammation, soft tissues acquire a spongy consistency and tendency to bleed, making it difficult to obtain accurate microsurgical incisions, divide the flap, and approximate the edges of the wound with microsutures. Patients who are candidates for periodontal and peri-implant plastic surgery should undergo prior periodontal treatment and present adequate oral hygiene according to the individual risk factors and no clinical signs of inflammation (ie, the gingival margin should firmly adhere to the root surface/implant). Because periodontal and peri-implant plastic surgeries are elective procedures, they should only happen in the absence of inflammation, which ensures greater predictability of the planned procedure.

Box 1-1 Local factors that influence wound healing

Lack of inflammation
Prerequisites for periodontal/peri-implant plastic microsurgery:
- Basic periodontal treatment and appropriate oral hygiene
- Gingival margin without clinical inflammation and adhered to the root surface/implant

Microsurgical approach
- Magnification: prismatic loupes or operative microscope
- Microinstruments
- Delicate handling of the tissues
- Minimally invasive techniques

Biocompatibility of root surface implant
- Root biocompatibility is fundamental for root coverage treatment of gingival recession.
- The preparation of exposed root surfaces is performed prior to starting surgery.
- The choice of material and the design of the prosthetic abutments are fundamental to the intital healing and maintenance of the results.

Flap design
- Microenvelope technique: when the flap does not require a large coronal displacement
- Semilunar technique: favors flap mobility and interdental tissue nutrition (see chapter 6)

Blood supply to flap margins
- 90-degree angled flap margins (suppress beveled incisions)
- The initial incision should always be made with the scalpel blade perpendicular to the tissue surface.
- Uniform flap thickness to preserve nourishment
- Minimal trauma to the flap edges

Flap thickness
The flap thickness should be uniform while preserving the minimum necessary connective tissue.

Tension over the flap
Edge-to-edge wound closure should always be tension free.

Microsutures
Must be divided into two phases: approximation and coaptation.

Clot thickness
Clot should be thin throughout the surgical wound.

Modified from Zuhr and Hürzeler.[14]

Microsurgical approach

One of the critical keys to proper wound healing is the use of a microsurgical approach. The four essential elements are: magnification (prismatic magnifying loupes or operative microscope), microinstruments, gentle tissue manipulation, and use of minimally invasive techniques. The main objective of a treatment based on these four elements is to achieve primary wound closure through gentle tissue manipulation with maximum precision.

Biocompatibility of root surface/implant

The biocompatibility of the root surface/implant is necessary for the healing process and successful treatment of soft tissue defects. Even in individuals with optimal control of dental biofilm, a thin layer of this biofilm usually covers the exposed root/implant surfaces. Thus, mechanical cleaning of these surfaces should be done immediately before surgery to remove all biofilm and microorganisms, which will in turn favor the adhesion of soft tissues. A periodontal/peri-implant abscess may form instead of a new adhesion to the root surface, or a long junctional epithelium may form on the implant surface when biocompatibility is not present. Another critical factor in the case of implants is the choice of material and the

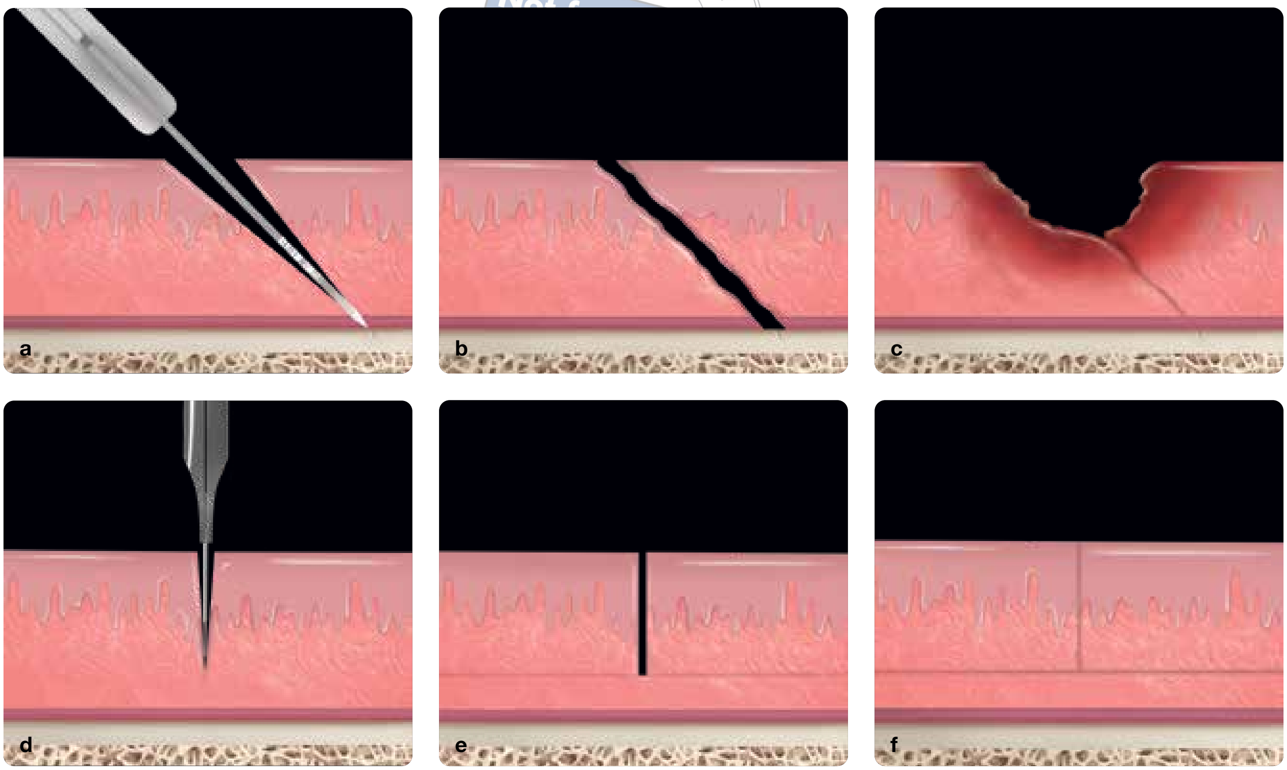


Fig 1-6 *(a to c)* Beveled incision. Conventional incisions are often beveled, leaving part of the epithelium without nourishment from the connective tissue. The consequence is healing by secondary intention. *(d to f)* Incision perpendicular to the tissue surface. In microsurgery, the incisions are always at a 90-degree angle, allowing for edge-to-edge closure of the surgical wound and consequent healing by primary intention.

design of the prosthetic abutments, which are fundamental for the initial healing and maintenance of the results (see chapter 6).

Flap design

This book presents the periodontal microsurgical techniques with split flaps, classified into two groups: the microenvelope technique and the semilunar technique. The microenvelope technique is used to avoid large coronal displacements. The semilunar technique is used in cases where more significant displacement is required, with the advantage of favoring interdental nutrition (see chapter 6).

Blood supply to flap margins

The edges of the flap are the most critical areas throughout the wound healing process. Maintaining a good blood supply needs to be a central objective of all stages of the microsurgical procedure. The risk of flap edge necrosis is inversely proportional to its thickness. The thinner the flap, the smaller the number of blood vessels that nourish its edges, and the higher the risk of postoperative necrosis. When initial microincisions are made, the scalpel blade should be at a 90-degree angle to the tissue surface, and beveled incisions should always be avoided (Fig 1-6). If these fundamental rules are followed, the flap will have uniformly thick right-angled edges rather than sharp-angled edges. Soft tissue design and atraumatic management are essential for good postoperative perfusion and prevention of flap edge necrosis.

The risk of flap edge necrosis is inversely proportional to its thickness.

Flap thickness

Obtaining a uniformly divided flap is crucial for blood perfusion along its edges and primary intention healing. The advantage of using magnification is that accurate and uniform flaps are obtained even in thin periodontal phenotypes (thickness < 0.8 mm).

Tension over the flap

During microsuture completion, an accurate approach without edge tension is another decisive factor in the primary wound closure. Failure to follow these principles may result in contraction and collapse of blood vessels, which complicate blood perfusion in the flap and consequently increase the risk of necrosis and healing complications. Flap tension is also associated with the risk of postoperative recession, which may result in secondary intention healing and its consequences. The choice of a suitable design and uniform thickness throughout the flap ensures proper flap mobility (without tension). A tension-free approach to the wound edges is therefore crucial to the success of periodontal and peri-implant plastic surgery.

A tension-free approach to the wound edges is therefore crucial to the success of periodontal and peri-implant plastic surgery.

Microsutures

In microsurgery, there are two stages of microsutures: approximation and coaptation. The approximation stage is responsible for the approximation of the flap/graft/bed joint, and the coaptation stage is responsible for the precise joining of the flap edges (see chapters 3 and 6).

Clot thickness

The clot thickness should be as thin as possible throughout the surgical wound, which favors primary intention healing.

Systemic factors

Box 1-2 outlines the systemic factors that may influence wound healing. These are discussed in the sections that follow.

Diabetes

Tissue perfusion disorders associated with diabetic micro- and macroangiopathies impair local immune defenses and wound healing. Consequently, diabetic patients are at high risk for healing complications and necrosis, mainly when diabetes is uncontrolled. When treating these high-risk patients, the surgeon should consult the patient's primary care physician to fully understand the scope of the patient's disease. The glycated hemoglobin fraction is of great value in prolonged monitoring of glycemic treatment. A value of less than 6.5% indicates that diabetes is controlled, and predictable and satisfactory results are expected. Elective surgery should never be performed on individuals with untreated or uncontrolled diabetes. Even in patients with controlled diabetes, surgery should be performed under prophylactic antibiotic coverage.

Elective surgery should never be performed on individuals with untreated or uncontrolled diabetes.

Box 1-2 Systemic factors that influence wound healing

Diabetes
- Contact the patient's physician.
- Periodontal plastic interventions may be performed if diabetes is well controlled.
- Prophylactic antibiotic coverage is recommended even if diabetes is controlled.

Immunosuppression
- Contact the patient's physician.
- Prophylactic antibiotic coverage is necessary for microsurgeries.
- In patients with HIV or AIDS, surgical procedures may be performed during the latent phase.

Patient-specific factors
Each patient has an individual healing process.

Stress
Surgical procedures are contraindicated in patients with advanced degrees of emotional stress.

Smoking
In active smokers, periodontal and peri-implant plastic microsurgery presents less predictable results.

Modified from Zuhr and Hürzeler.[14]

Immunosuppression

Immunosuppressive drugs, such as cytostatics and corticosteroids, decrease the patient's immune response and therefore may impair or delay wound healing. Surgical procedures should never be performed under immunosuppressive treatment without consulting the patient's physician. Procedures should be performed under prophylactic antibiotic therapy. An accurate approach to the wound edges is critical to avoid complications during healing in such cases. In patients with HIV or AIDS, modern antiretroviral drugs and treatment protocols have increased the viability and prognosis of surgeries. Periodontal/peri-implant surgical procedures should be avoided during the acute phases of HIV infection and after the outbreak of AIDS but may be performed under prophylactic antibiotic therapy during the latency period of infection.

Patient-specific factors

Even considering all known factors that are relevant to healing, patient-specific factors result in individual differences. Age plays an important role; studies have shown that patients older than 70 years have lower success rates in wound healing than younger patients. Genetic predisposition, especially the expression of growth factors, seems to be another critical patient-specific factor in healing. Growth factors are involved at various stages of healing, as they are chemotactic for fibroblasts and stimulate immune cells and angiogenesis.

Stress

Stress and anxiety can slow wound healing due to increased cortisol in the bloodstream. Cortisol is a hormone in the steroid family produced by the upper adrenal gland and is directly involved in stress response. Cortisol's metabolic and anti-inflammatory activity is essential for the survival of patients with trauma or infections. Conversely, cortisol at high doses or with prolonged administration increases predisposition to infection, facilitates its spread, and makes healing difficult.[18]

Smoking

Nicotine and toxic aerosols in tobacco smoke have systemic effects on oral wound healing. When associated with local factors that directly influence tissue healing, they prevent the blood supply from reaching the tissues and reduce immune defense. Surgeons should anticipate healing complications in active smokers, even if microsurgery is carefully planned and performed. In patients who smoke, the results are less predictable.[14,16]

Surgeons should anticipate healing complications in active smokers, even if microsurgery is carefully planned and performed.

Healing complications

Whenever tissue integrity is disrupted by accident or dehiscence, the patient becomes vulnerable to infection and various complications.[17] Even in cases where the entire surgical team strictly follows the protocols inherent to the procedure, some complications may occur during the postoperative period. The two biggest problems are infection and suture dehiscence.

Infection

Infections are caused by the entry of virulent microorganisms into a susceptible surgical wound. The key to treatment is to rapidly identify the responsible pathogens (usually of bacterial origin) and immediately treat the infection with specific antibiotics. In addition to prescribing antibiotics and a 0.12% chlorhexidine gluconate rinse (two times per day), surgeons should carefully remove necrotic remains and induce local asepsis with 2% chlorhexidine gel. The protocol continues until there is complete remission of symptoms and total epithelialization of the wound. In the case of periodontal plastic surgeries, which are considered relatively superficial wounds, there is no need for more invasive procedures, such as drainage through incisions or debridement of necrotic tissue.

Dehiscence

Wound dehiscence is a total or partial separation of the tissue layers after closure. It may result from too much tension applied to the newly sutured tissue, improper technique, or improper use of suture materials. In periodontal and peri-implant plastic surgery, wound dehiscence relates to the characteristics of the periodontal phenotype; the thinner the tissues, the higher the possibility of dehiscence. When dehiscence occurs, the wound may or may not be closed again, depending on the extent of the rupture and the surgeon's assessment. It is often preferable to wait for the final healing to assess the need for further intervention.

In periodontal and peri-implant plastic surgery, wound dehiscence relates to the characteristics of the periodontal phenotype; the thinner the tissues, the higher the possibility of dehiscence.

History and Principles of Minimally Invasive Surgery

The esthetics of the periodontal and peri-implant soft tissues is a determining factor for the success of any treatment. Periodontal plastic surgery procedures are challenging to perform and quite sensitive to failures, and the esthetic results of soft tissues are variable and do not always meet patients' expectations. Over the past few decades, the growing interest in less aggressive, more predictable, and well-targeted periodontal surgeries has challenged clinical researchers to pursue other surgical approaches.

From Conventional Surgery to Microsurgery

The conventional approach is often based on large, beveled incisions (see Fig 1-6a to 1-6c), releasing vertical incisions, the reflection of large mucoperiosteal flaps, and coarse and randomly placed sutures (Fig 1-7). Overexposure of bone during surgery leads to some degree of postoperative resorption,[19] large incisions increase tissue trauma and transoperative bleeding, and randomly placed sutures are not able to adequately approximate the edges of the flaps (Fig 1-8). In the end, the surgical wound may have empty spaces and overlapping flaps. As clinical consequences, patient discomfort (pain, edema, late bleeding, hematoma), necrotic areas, variable results, and healing by secondary intention can occur. In esthetic surgeries, the possibility of unexpected soft tissue recession during and after healing leads to esthetic concerns from patients,[20,21] in addition to postoperative pain and discomfort.[22,23] This negative pattern may make it difficult for patients to accept periodontal surgical procedures.

Over the past 25 years, minimally invasive procedures have begun to be incorporated into clinical periodontal procedures to favor different therapeutic approaches.[24,25] This trend is in line with the current principles of the medical community, which has routinely used the minimally invasive philosophy to achieve better surgical outcomes with a more comfortable postoperative period and reduced length of hospital stay (eg, reconstructive, laparoscopic, endovascular vascular surgery, eye care). According to Hunter and Sackier,[26] this therapeutic approach has been described as "the ability to miniaturize our eyes and extend our hands to perform macro- and microscopic surgery in areas that previously could only be accessed with large incisions."

Harrel and Rees[27] initially described minimally invasive surgery (MIS) to reduce periodontal surgical wounds. The MIS approach involves making small incisions, dividing the flap to preserve the periosteum to maintain blood supply, and performing delicate sutures. To improve visualization during minimally invasive procedures, the videoscope was developed.[28] This device inserts a small camera and a light source into the periodontal defect. The image appears on a monitor, helping the surgeon visualize the roots of the teeth and the bone inside the periodontal defect. The authors reported better clinical results obtained with the videoscope than when performed with other visualization methods.[29]

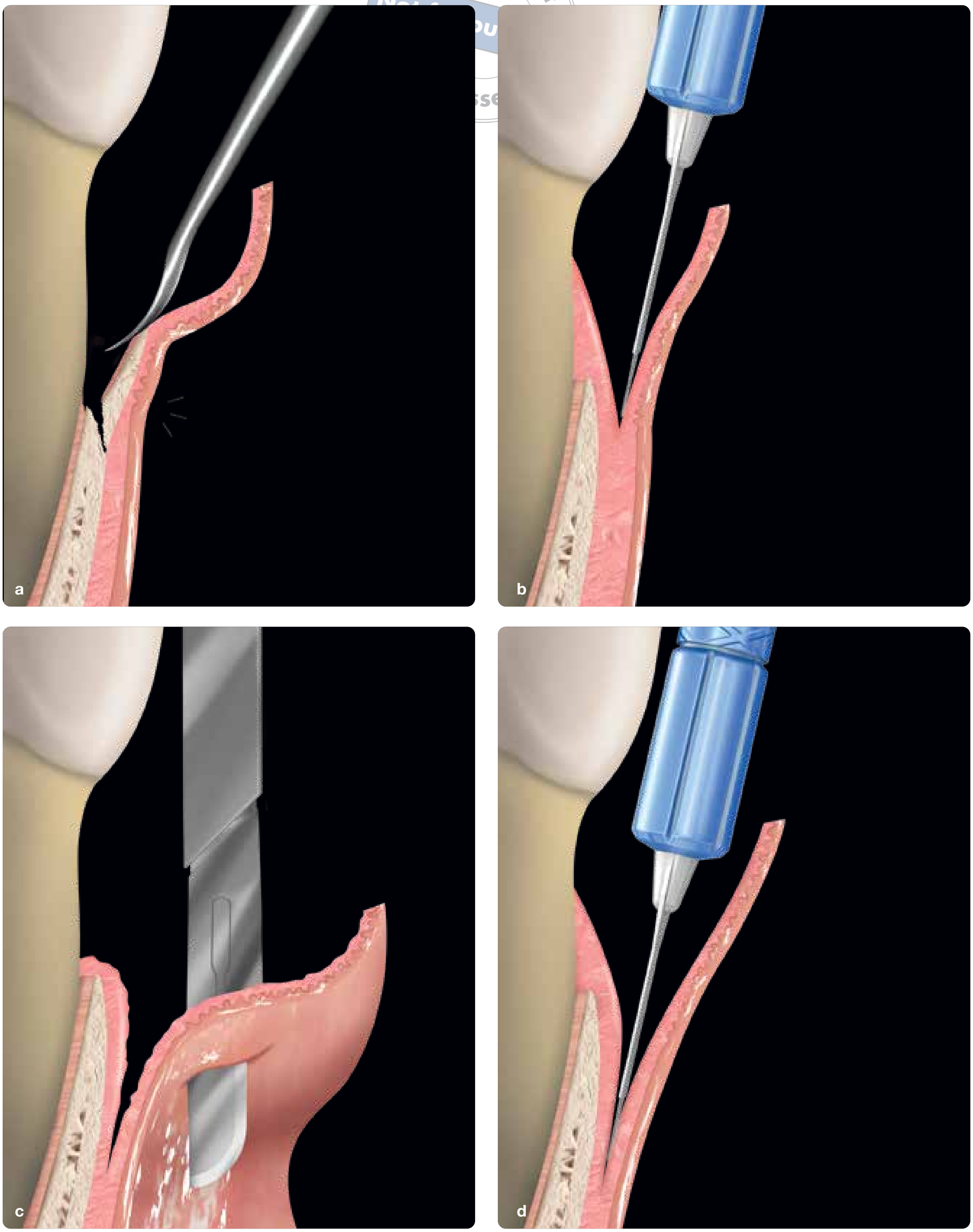


Fig 1-7 *(a)* Reflection of a total-thickness flap in thin periodontal phenotypes can be quite traumatic to the soft tissues. *(b)* The microblade allows the flap to be divided even in thin periodontal phenotypes. *(c)* The use of conventional blades makes it challenging to obtain a uniform flap and causes flap perforations. *(d)* The microblade allows the division of the flap over the mucogingival line, maintaining the desired thickness.

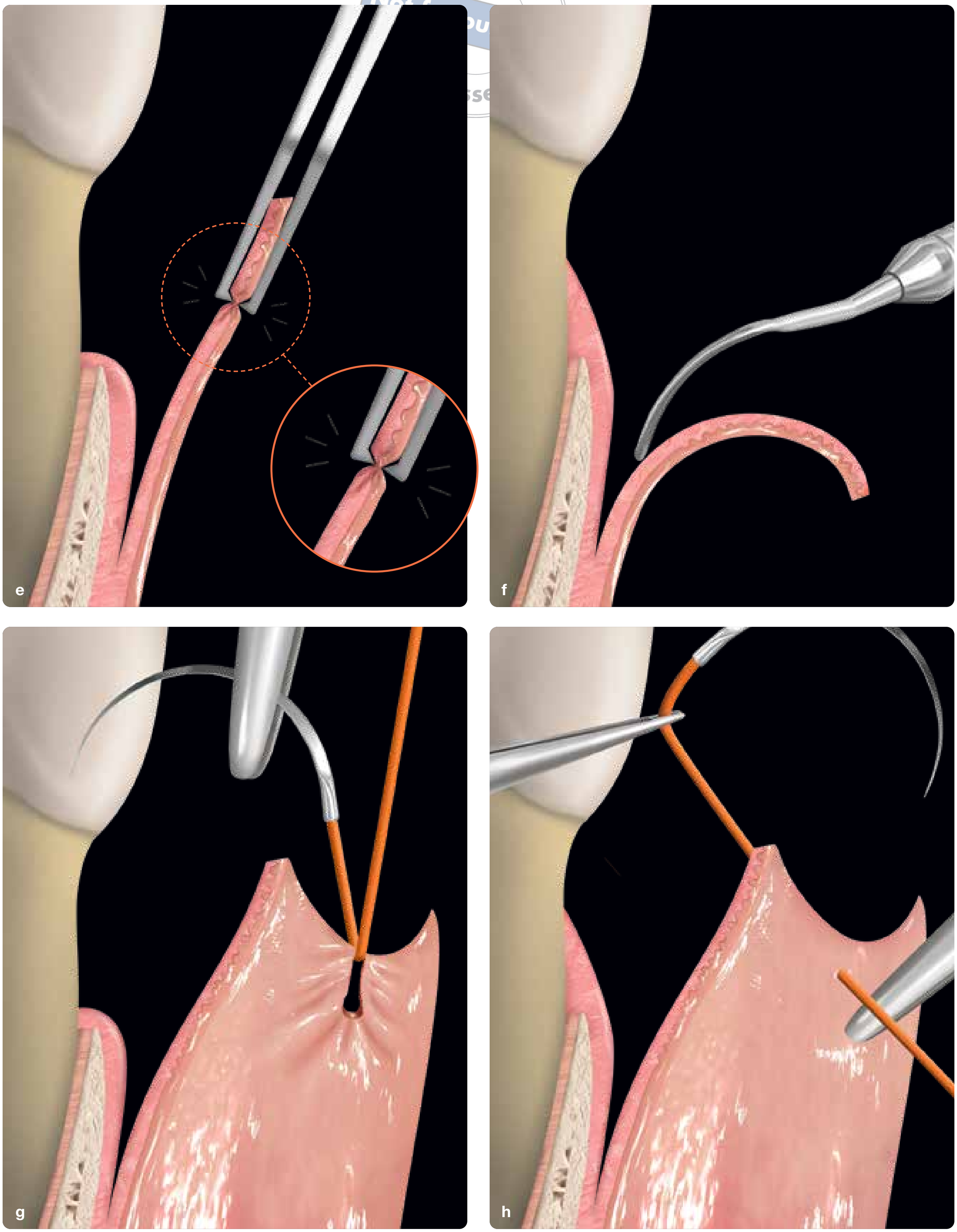


Fig 1-7 *(cont)* *(e)* Conventional macroscopic maneuvers, such as holding flaps with traumatic pliers, can tear the tissues. *(f)* Microinstruments allow delicate tissue retraction. *(g)* Improper suture threads and unrefined techniques increase needle-generated perforation. *(h)* Microsuture techniques restrict tissue perforation according to needle diameter.

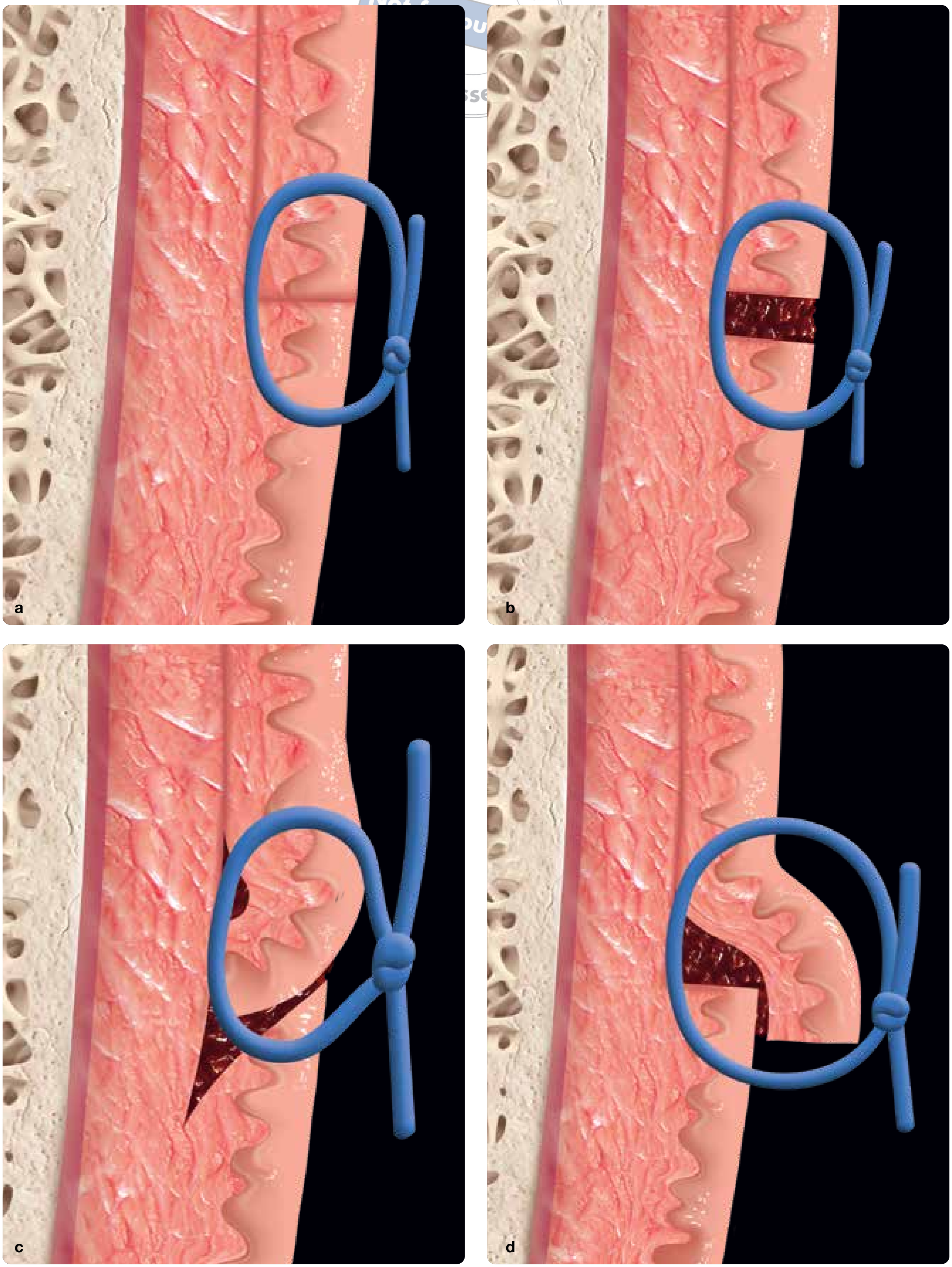


Fig 1-8 *(a)* Ideal suture. *(b)* Inadequate loose suture. *(c)* Inadequate invaginated suture. *(d)* Overlapping inadequate suture.

Cortellini and Tonetti[24] also use a minimally invasive surgical technique (MIST), which emphasizes aspects of papilla preservation, primary wound closure, and clot protection and stabilization. Subsequently, they developed the modified minimally invasive surgical technique (MMIST),[30] which incorporates the concept of space prediction for regeneration.

Cortellini and Tonetti[31] proposed the use of the operative microscope in periodontal regenerative surgery. They reported an improvement in soft tissue manipulation, which resulted in an increase in primary wound closure from an average of 70% of cases obtained with conventional surgery to 92% obtained with microsurgery.

Ribeiro et al[32] showed that the use of MIST associated with the application of enamel-derived protein matrix promoted statistically significant clinical improvements, minimal pain and discomfort, and maximum esthetic outcomes. Another study[33] reported that there was no gingival margin migration in the 6-month postoperative period.

The main difficulty of implementing MIS is controlling the operative field. In the reduced surgical area, using instruments with small tips to handle thin and delicate tissues constitutes a challenge that is often impossible to the naked eye. Therefore, the authors proposed a system of magnification of the operative field, such as magnifying loupes, endoscopic visualization (ie, videoscope), or operating microscope. These systems have proper lighting to achieve detail in all areas of the oral cavity. Thus, the initial definition of MIS, which did not consider the obligatory use of magnification,[26] was changed to "reduced and more precise surgical approaches performed through magnification systems, instruments, and microsurgical materials."[34]

In the reduced surgical area, using instruments with small tips to handle thin and delicate tissues constitutes a challenge that is often impossible to the naked eye.

The development and refinement of MIS were widespread and enhanced by the use of an operative microscope, magnifying loupes, and microinstruments. Several authors[35–38] have reported better results using an operative microscope in different areas of periodontal surgery, from flap surgery to periodontal plastic surgery.

Shanelec and Tibbetts[7–13] introduced the concept of periodontal microsurgery as a refinement of conventional surgery through the use of magnification and specific microinstruments. The incorporation of the microsurgical principles was decisive for the emergence of the protocols of periodontal plastic microsurgery. Techniques such as reduced incisions perpendicular to the tissue surface, delicate and precise tissue handling, and suture geometry provided primary wound closure and systematic primary intention healing. The addition of these techniques has contributed significantly to the increased predictability of surgical outcomes and the treatment of gingival defects that are difficult to solve with conventional techniques.

Through literature reviews, case reports,[39–44] and comparative clinical studies,[45–48] other authors have indicated the use of the operative microscope for the treatment of gingival recessions.

Burkhardt and Lang[45] performed a comparative study with a SCTG for root coverage by fluorescence angiographic evaluation. The microsurgical technique demonstrated a higher degree of revascularization when compared to the macrosurgical technique (ie, without the use of the operating microscope). There was also a statistically significant difference favorable to the microsurgical approach in the percentage of root coverage (98% versus 90%).

In a controlled clinical study, Francetti et al[46] compared the micro- and macrosurgical approach in 24 patients with three different techniques and several operators. After 1 year of follow-up, no statistically significant differences were found between microsurgical and macrosurgical approaches for mean root coverage (86% versus 78%, respectively) and complete root coverage (58.3% versus 33.4%, respectively). However, a qualitative photographic analysis performed by three examiners revealed that the microsurgical approach provided better marginal gingival contour and better healing pattern.

In a controlled clinical study, Bittencourt et al[47] compared the periodontal microsurgery technique for root coverage in one group with the use of SCTG and in the other group with the coronally positioned semilunar flap technique (both using the operative microscope). The results showed that both techniques obtained a significant percentage of root coverage (96% versus 91%, respectively), with no statistical difference between the groups.

Bittencourt et al[48] also conducted a randomized controlled clinical trial in 24 patients with bilateral Miller Class I or II gingival recession greater than or equal to 2 mm located in canines or premolars. All surgeries were performed by a single operator who used the SCTG technique in a minimally invasive approach (advocated by Shanelec and Tibbetts[7–13] and modified by Campos et al[41]), using the same instruments and materials for both groups (microblade and sutures 6-0 and 8-0). The only exception in materials was the operative microscope (used in the MICRO group), which was not used in the control group (MACRO group). The results of this study demonstrated that both the MICRO and MACRO approaches promoted satisfactory root coverage percentages at 98.0% and 88.3%, respectively. However, these percentages showed a statistically significant difference favorable to the MICRO treatment with the operative microscope. After surgery, no residual or additional cervical dentin hypersensitivity (CDH) was reported by patients in the MICRO group, while 27.3% of the patients in the MACRO group reported CDH. Regarding the esthetic result, the MICRO and MACRO groups reported 100% and 79.1% of patient satisfaction with the esthetic outcome, respectively. The authors concluded that both approaches are capable of promoting root coverage, but using an operative microscope brings additional clinical benefits to the treatment of gingival retractions.

Considering specifically validated studies on the use of micro- versus macrosurgery, Chambrone and Tatakis[43] indicated that SCTG-based procedures, when employed with the aid of microsurgery, can promote an additional 9% gain in mean root coverage when compared to conventional techniques. They also favor greater short-term root coverage (6 months). These minimally invasive techniques, employing magnification and microinstruments, have shown more satisfactory results in terms of the early postoperative period and the amount of root coverage.

Magnification in Periodontics

Diagnostic phase

The most common means used to diagnose periodontal disease are visual examinations aided by a periodontal probe and radiographs.[49] The probe markings from millimeter to millimeter are viewed with comfort and precision. The extended operative field allows the probe to penetrate precisely into the sulcus/pocket without exceeding its biologic limits.

Initial treatment phase

Scaling and root planing is one of the most critical procedures of periodontics.[50,51] The detailed visualization of soft and hard tissue structures allows the preservation of the involved tissues and the selective removal of dentin contaminated with dental calculus and biofilm. This technique allows a delicate curette to penetrate exactly into the periodontal sulcus/pocket at a favorable working angle for the removal of subgingival contamination.[52] It also avoids soft tissue trauma (laceration) by privileged visualization of the structures. In addition, it allows for standardization of tooth structure removal, avoiding irregular dentin removal in the different root surfaces. Thus, postoperative dentin sensitivity is decreased or even eliminated.

Regenerative surgery

Several authors have proposed the use of the microsurgical approach for the treatment of isolated[24,27,30,35] or multiple[29,34] defects. The microsurgical approach improves illumination and magnification of the operative field, allowing access to the intraosseous defect with greater precision in decontamination and minimal tissue trauma.[24,34] In addition, the possibility of obtaining and maintaining primary wound closure minimizes bacterial contamination and creates more favorable conditions for periodontal regeneration.[30,35] Other advantages of this approach in intraosseous treatment include minimal tissue retraction, improved esthetics,[24,29,32] reduced postoperative morbidity, and high patient acceptance and satisfaction.[24,28–30,32,35,37]

Root coverage surgery

For predictable esthetic and functional results, it is essential to perform small incisions and meticulous sutures. Graft stabilization and immobilization occur through the precise closure of the wound edges. Compared to conventional surgery, the microsurgical approach has shown the advantages of increased graft vascularization,[45] higher percentages of root coverage,[43,45,46,48] a significant increase in width and thickness of keratinized tissue,[44] better esthetic result, and decreased patient morbidity[43,45,46,48] (see chapter 6).

Crown lengthening surgery

Although comparative studies of surgical crown lengthening[53] with microsurgical methods are limited, the expectation that magnification may be advantageous for this procedure seems logical. The development of new digital surgical planning methods and the manufacture of precise and customized surgical guides have posed a challenge for microsurgical techniques. Controlling initial microincision, flap management, osteotomy, and microsuturing prevents unwanted postoperative tissue recession. Chapter 7 presents a new microsurgical protocol created especially for the digital smile design technique.

Implant dentistry

Magnification and microsurgical techniques can be used at different stages of treatment with implants (at placement, peri-implant plastic surgery, and peri-implant management) with greater precision and predictability[54,55] (see chapter 6). Another application is the maxillary sinus elevation procedure, with a significant increase in the success rate.[56,57] Magnification may assist in the maxillary sinus osteotomy in visualizing and detaching the sinus membrane, minimizing the risk of perforation.

Clinical Implications of MIS

The use of magnification and microinstruments will only be able to achieve significant clinical results if the operator follows an MIS philosophy and well-defined technical protocols (Box 1-3). Chapters 3 and 6 present principles aimed at solving soft tissue defects with a strong emphasis on root and peri-implant coverage. Thus, significant clinical advantages can be expected when compared to conventional procedures:

- Microinstruments, magnification, and microsurgical techniques make it possible to reduce the size of the operative field considerably. The larger the treated area, the more significant the inflammatory process and, consequently, the edema, postoperative pain, and healing time. Therefore, limiting the extent of the surgical area is necessary to reduce morbidity.
- The more compromised the blood supply in the manipulated tissues, the higher the risk of necrotic areas, with esthetic and functional consequences.
- Because flap design is essential in preserving blood supply, unfavorable incisions that impair blood perfusion in the tissue should be avoided. As an example, releasing vertical incisions in the recipient and donor area (palate) are recommended to facilitate access to connective tissue. In the same manner, immediate implant placement associated with an SCTG can be done without releasing incisions through magnification and proper illumination. Avoiding releasing incisions represents an undeniable advantage for blood flow in the surgical area and for preserving hard and soft tissue architecture (see chapters 8 and 9). In addition to the minimal risk of scarring, microsurgical techniques can lead to faster graft revascularization.[45]

Box 1-3 Principles that underlie MIS and its benefits

Technical approach	Clinical benefits
• Gentle tissue manipulation	• Reduction of surgical trauma
• Reduced incisions	• Primary intention healing
• Minimal elevation of the flap	• Postoperative tissue stability
• Papillae preservation	• No or little postoperative pain
• Preservation of blood supply	• Reduced need for medication
• Delicate sutures	• Reduced number of procedures
• Clot protection and stability	• Less chair time
• Primary surgical wound closure	• Superior clinical results

- Soft tissues react less well to smashing than to incisions or perforations (see Figs 1-7c and 1-7e). The electrolytic process guarantees the precision of the microblades instead of being machined like conventional blades.[58] The edge of the microblades is thinner and smoother and the surface texture is softer, resulting in an accurate incision with minimal tissue trauma. In addition, the use of tissue pliers and microretractors allows surgeons to gently control soft tissues (see Figs 1-7f and 1-7h). In comparison, the use of unrefined instruments is more likely to crush fragile tissues and potentially induce necrosis (see Figs 1-7a and 1-7e).
- Microsutures favor primary closure of the surgical wound (edge-to-edge), leading to primary intention healing.
- Primary intention healing is more desirable than secondary intention healing. Thus, there is a reduction in edema, postoperative pain, healing time, and risk of scarring. These factors contribute to the greater acceptance of patients for new surgical procedures.
- The high predictability of microsurgery reduces chair time and the risk of having to repeat procedures. As an example, the treatment of deep gingival recessions usually requires two or more interventions with conventional surgery. This same treatment is done in one single microsurgery procedure.
- Reduced intraoperative bleeding, better visualization of the operative field, comfortable working posture, better clinical results, and satisfaction with the successful procedure contribute to a better working environment.

Paradigm Shift

The biggest challenge in the use of clinical magnification is the need for surgeons to change their existing paradigms, because it implies exiting our comfort zone.

The biggest challenge in the use of clinical magnification is the need for surgeons to change their existing paradigms, because it implies exiting our comfort zone. When surgeons can see the periodontal probe penetrating the gingival sulcus through the gingival tissues, the examination parameters change. In addition to precision, the procedure becomes more delicate and less invasive. When applying these principles to periodontal plastic surgery, magnification and microinstruments enable the development of techniques that would be intangible to the naked eye. The visualization of the tissue's texture and surface in an objective and realistic manner guides the positioning of the microinstruments while respecting the biologic principles. New techniques can then be created and developed, and they can potentially lead surgeons to go beyond frontiers.

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