

THE ART OF DENTAL SUTURING

A CLINICAL GUIDE



A. Burak Çankaya
Korkud Demirel

THE ART OF DENTAL SUTURING

A CLINICAL GUIDE

THE ART OF DENTAL SUTURING

A CLINICAL GUIDE

A. Burak Çankaya, DDS

Professor
Istanbul University
Faculty of Dentistry
Department of Oral and Maxillofacial Surgery

Korkud Demirel, DDS

Professor
Istanbul University
Faculty of Dentistry
Department of Periodontology



Berlin | Chicago | Tokyo
Barcelona | London | Milan | Mexico City | Moscow | Paris | Prague | Seoul | Warsaw
Beijing | Istanbul | Sao Paulo | Zagreb

First published in Turkish

"DİŞ HEKİMLERİ İÇİN CERRAHİ DİKİŞ SANATI KLİNİK REHBERİ – III"

© 2019 Quintessence Yayıncılık Tanıtım Paz. ve Dış. Tic. Ltd. Şti.,
Büyükdere Cad. Sakarya Apt. 6/7 Şişli-İstanbul

A CIP record for this book is available from the British Library.
ISBN: 978-3-86867-558-0



Quintessenz Verlags-GmbH
Ifenpfad 2–4
12107 Berlin
Germany

Quintessence Publishing Co Ltd,
Grafton Road, New Malden,
Surrey KT3 3AB,
United Kingdom

Quintessenz Verlags-GmbH

All rights reserved. This book or any part thereof may not be reproduced, stored in a retrieval system, or transmitted in any form or without prior written permission of the publisher.

Editing: Avril du Plessis, Quintessence Publishing Co Ltd, London, UK
Layout and Production: Quintessenz Verlags-GmbH, Berlin, Germany

On the path that Atatürk has paved, toward the aims that he has set...

ACKNOWLEDGMENT

The start of this project dates back to October 2017. Although we started with much enthusiasm and energy, it did not take us long to understand that putting what we know on paper does not easily translate to performing the procedures in the clinic. Looking for new ways of telling the story took us to Ferhat Çevik, a self-improving, open-minded digital illustrator. We had never met him in person as he lives in another city, but our e-mail correspondence worked out perfectly, resulting in the magnificent illustrations in this book.

Undoubtedly, the illustrations alone were not sufficient; we also had to include the hand instruments for suturing. In this regard, Giana Spasic from Hu-Friedy provided generous support, as she always has, supplying us with all the necessary instruments in the shortest possible time.

So here we were, two authors from two different surgical disciplines, attempting to tackle instrument photography, again believing that whatever we know and do is right. We procured a photo light box, on top of all the photography materials we already had, and started to take photographs of our hand instruments. However, we realized soon enough that taking product photographs was nothing like taking family photos. It took us eight Saturdays and a pile of less-than-ideal-quality photographs to realize that this was not our forte either and that we needed help from professionals. Ahmet Koçak from Kandemir Photography came to the rescue and provided full support.

We would like to express our gratitude to Dr Ertuğrul Çetinkaya, the Managing Editor of Quintessence Türkiye, who mentored us through the process, and language editor, Avril du Plessis, for her exceptional cooperation.

We would therefore like to express our gratitude to all these esteemed and enlightened people whose support was essential in

making this book a reality. We would also each like to express our special thanks to one another, as co-authors, not merely for completing the book, but also for having a pleasant time and becoming good friends during this process.

January 2021

ABOUT THE AUTHORS



Professor A. Burak Çankaya, DDS, graduated from Kadıköy Anatolian High School in 1995, and from Istanbul University, Faculty of Dentistry, in 2000. He worked as a visiting lecturer at Klinikum Osnabrück GmbH – Klinik für Mund-, Kiefer-, Gesichtschirurgie in 2006 and 2007. He acquired his PhD in 2007 and became Professor in 2021. His professional areas of interest include impacted tooth surgery, dental traumatology, dental implants, and bone regeneration. He is a member of the Turkish Association of Oral and Maxillofacial Surgery.



Professor Korkud Demirel, DDS, graduated from Tarsus American School in 1980, and from Istanbul University, Faculty of Dentistry, in 1985. He worked as a visiting lecturer at New York University, Stony Brook School of Dentistry, Department of Periodontology in 1989 and 1990. He attained his PhD in 1992 and became Professor in 2002. He was awarded the title of Honorary Professor by the Ukrainian Academy of Postgraduate Education in 2018. His professional areas of interest include esthetic periodontal treatment, dental implants, bone regeneration, and smoking and gingival diseases. He was Past President of the Turkish Society of Periodontology, and was Past President of the European Federation of Periodontology.

CONTENTS

Acknowledgment

About the authors

Types of wound healing

Chapter 1: Wound healing

Introduction

Phases of wound healing

Hemostasis and inflammation

Proliferation

Remodeling and maturation

Typical characteristics of oral mucosal wound healing

Wound healing and systemic factors

Age

Nutrition

Dehydration

Diabetes

Nicotine intake

Diseases and/or therapies affecting the host defense mechanism

Drugs and wound healing

Antithrombotic therapy

Antiangiogenic agents

Antiresorptive agents

Corticosteroids

Local factors affecting wound healing

Direction and length of incision

Surface angle of incision

Hemostasis

Tissue moisture control

Removal of necrotic tissue and foreign bodies

Prevention of dead space in wounds

Tissue tension

Infection

Wound and clot stabilization

Blood supply to the wound site

Enhanced visualization

Recommended reading

Chapter 2: Suture materials and suturing instruments

Suture threads and needles

Physical properties of suture threads

Gauge

Physical structure

Capillarity

Tensile strength

Tissue passage

Knot-holding security

Elasticity

Shape memory

Absorption characteristics of suture threads

Absorbable suture threads

Absorbable natural suture threads

Absorbable synthetic suture threads

Non-absorbable suture threads

Non-absorbable natural suture threads

Non-absorbable synthetic suture threads

Suture needles

Needle anatomy

Hand instruments

Needle holders

Scissors

Tissue forceps

Tissue adhesives

Fibrin adhesives

Collagen and protein-based adhesives

Cyanoacrylates

Polyurethane adhesives

Recommended reading

Chapter 3: Suturing techniques

General principles of suturing

Suture characteristics

Suturing techniques

Operational safety

Function-based classification of suturing techniques

Wound closure sutures

Interrupted sutures

Simple and locking continuous sutures

Corner sutures

Displacement sutures for approximating wound margins

Sling sutures

View-enhancing (tissue retraction) sutures

Fixation sutures for biomaterials or grafts

Membrane fixation sutures

Sutures for adapting autogenous soft tissue grafts to the recipient site

Sutures for securing surgical dressings or packings

Hemostatic sutures

Positioning sutures

Sutures to prevent foreign material from traveling into deep tissue

Abscess drainage sutures

Recommended reading

TYPES OF WOUND HEALING

Diverse biologic events such as hemostasis, coagulation, inflammation, granulation, connective tissue formation, and reepithelization occur during wound healing and continue upon remodeling of the wound site, even after wound closure. The healing model where the wound edges are well approximated is known as primary healing or primary intention, and that where a gap is left between the wound edges is called secondary healing or secondary intention. However, in case of injuries with significant tissue loss and in which the wound is contaminated with bacteria through contact with a foreign body, the wound is often left open for a couple of days to avoid the risk of infection, and then closed once this risk is eliminated. This is known as tertiary healing. In such cases, the wound should be irrigated with saline while it is left open.

In primary healing, the wound remodels rapidly with a very small amount of granulation tissue formation, whereas in secondary healing, a void exists between the wound edges, resulting in more granulation tissue formation. In these types of injuries, the epithelium needs to extend further to cover the wound surface by filling the gap between the wound edges due to tissue loss. This indicates prolonged epithelization compared with primary healing. In addition, healing becomes more complicated in contaminated wounds with the additional process of eliminating the infection.

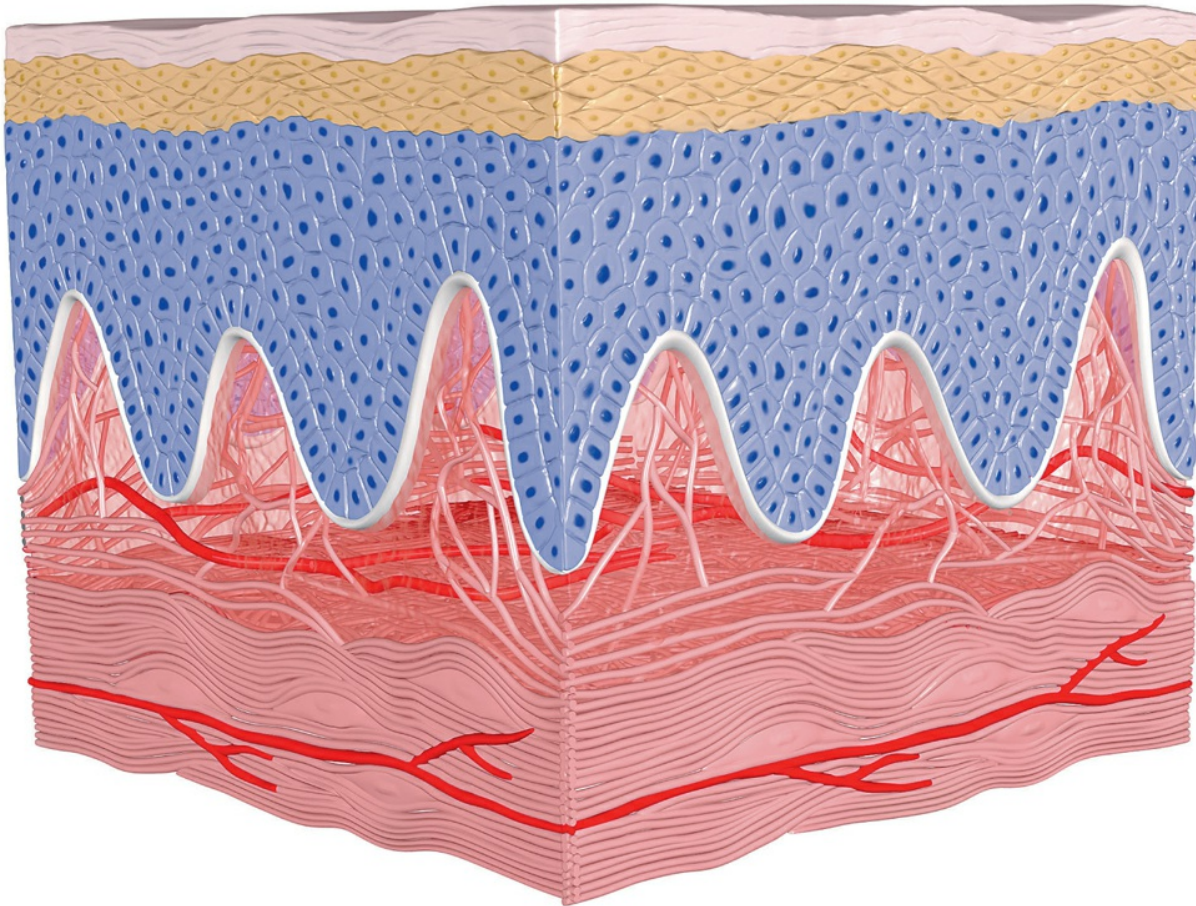
Wound healing takes place through either regeneration or repair of damaged tissue. Healing through regeneration involves the recovery of lost tissue with that which is structurally and functionally similar to the original. In healing through repair of damaged tissue, however, structure and function are not of primary importance; the main goal in such cases is the closure of the wound using available onsite cells and/or mechanisms. Whether the tissues heal through regeneration or repair depends on the availability of the required cells, the existence of signals to be transmitted to stimulate these cells, and the distance

between the wound edges. The duration of healing varies depending on local and systemic factors.

Wound healing is managed by inflammation resulting from the complex interaction between cells, soluble substances, molecules, and perfusion. The outcome and duration of healing is estimated by the timing of these interactions and associations as well as the magnitude, severity or duration of their mutual activities. Over the past decade, significant progress has been made in exploring some of these processes. Important insights have been provided by various models used to inhibit healing processes that yield poor outcomes (i.e. non-healing wounds, chronic wounds or wounds leaving scars) and in identifying underlying mechanisms that ensure wound healing. Regeneration is preferred to reparative tissue when it comes to healing, as the former is associated with no scars and with improved function. Recent research studies have therefore focused on regenerative healing.

CHAPTER 1

WOUND HEALING



INTRODUCTION

All surgical residents, as rookies, are somehow first assigned suturing tasks. In fact, suturing is one of the most important phases of surgery, if not the most important, requiring utmost concentration and adaptation of the technique to prevailing circumstances. Therefore, considering its significant contribution to the success of surgical procedures in general, we feel that suturing ought to be approached as an art that deserves appreciation and advancement.

The use of sutures in surgical procedures dates back to the 16th century BC. Various materials have been used since then, including horse mane hair, bristle, gold or silver filigrees, silk, silkworm guts, linen, cotton, and the tendons or viscera of various animals. The common function of these materials and procedures is to hold wound edges in approximation until the time of completion of healing, to secure them at the desired position, to protect the wound from physical external factors or microorganisms, to stabilize clots for hemostatic purposes, and to keep the tissues together with the aim of shortening healing time and thus improving the patient's quality of life.

Biologic and technological advances in recent years have resulted in a variety of suture threads being introduced. Factors influencing the choice of suture to be used may vary depending on the patient, wound, tissue characteristics, anatomical position, and procedure to be performed. The preference of the surgeon also plays an important part; the surgeon's experience is relevant because a good knowledge of the properties of suture materials is essential in making the correct choice.

No single suture material currently available on the market can fulfill all surgical requirements. Consequently, the structural characteristics of sutures should be considered for a better understanding of where best to use them. These characteristics include, but are not limited to, suture thread materials, capillarity, tensile strength, knot holding security, elasticity, memory, tissue reactivity, ease of handling, and ready-to-use form. By the same token, no single suture is ideal in all

circumstances or conditions. More importantly, suture type should be chosen based on the characteristics of the wound, considering the aforementioned aspects.

Wound characteristics play a key role in wound healing. Therefore, an accurate assessment of the wound healing phases would facilitate decision making compatible with the circumstances.

This book comprehensively covers the healing of surgical wounds, with a focus on scalpel-induced incision wounds. It should be borne in mind, however, that although wound healing phases and tissue response are identical in traumatic injuries, irregularity of wound edges and additional problems introduced by microorganism contamination may further complicate the healing process.

PHASES OF WOUND HEALING

Wound healing is basically divided into three major phases. The first is hemostasis and inflammation, where there is an attempt by the body to restore the tissue integrity and during which contaminated components are removed from the wound. The next is the proliferation phase, where the cells required for reorganization migrate from neighboring tissue and new tissue is formed. The last is the remodeling and maturation phase, where the newly formed tissue is organized to harmonize with the peripheral tissue.

Hemostasis and inflammation

Intraoral soft tissue healing is subject to the same principles as the healing of other bodily tissues. Wound healing starts with hemostasis to preserve the integrity of the organism; the organized form of this is known as coagulation. Traumatic and/or surgical damage results in capillary injury and hemorrhaging, which is the organism's self-protection mechanism. Wound healing is delayed if hemorrhaging starts and stops repeatedly, as this impairs granulation tissue formation. The development of alveolitis and the resultant pain in

patients with recurrent hemorrhaging following surgery may be associated with this impairment. The consequences of low viscosity, including the problem of the instability of blood, are addressed by the coagulation process. Coagulum serves two main functions: to temporarily protect the exposed tissue, and to create a temporary matrix – known as the fibrin plug – for the cells to migrate from neighboring wound edges. Coagulation is followed by inflammation, constituting the basis for wound healing.

Wound healing is a well-managed interaction between the cells of key importance (i.e. neutrophils, monocytes, lymphocytes, endothelial cells, and fibroblasts) and soluble regulating and signaling molecules (mediators) moderating intercellular substance synthesis. Coagulum typically contains a high number of neutrophils and macrophages that are released immediately following injury. These cells start to remove the necrotic and/or damaged tissue and microorganisms by secreting phagocytosis, toxic oxygenation products, and enzymes, and by releasing signaling molecules rich in polypeptide mediators, addressing cells that are effective in the wound healing process. These growth factors and cytokines released by macrophages play a central role in the proliferation of primarily fibroblasts and endothelial cells as well as smooth muscle cells, indicating the transition to the proliferation phase of healing. Although inflammation is an indispensable healing phase, the over or under release of inflammatory mediators may adversely affect the wound healing process. Inflammation reaches its final stage on or around the third day.

Proliferation

This complex process incorporates angiogenesis, the formation of granulation tissue, collagen deposition, epithelialization, and wound retraction. These processes occur simultaneously at various levels in different parts of the wound. Angiogenesis is triggered from the moment the hemostatic plug has formed, once the platelets have released growth factors. As the process of angiogenesis progresses, a

rich vascular network of capillaries is formed; thus, nutrients and new cells are transferred to the healing front. With the cellular level signaling, fibroblasts populate the wound space and excrete the extracellular matrix proteins. This clot is gradually replaced by vulnerable hemorrhagic vascular tissue, which is called granulation tissue. This tissue lays the foundation for epithelial migration, where epithelial cells migrate from the edges of the wound to seal the surface and provide the basis for the formation of connective tissue. During this period, the color of the wound starts to return to normal, with typical characteristics, and it develops resistance to trauma.

Although healing takes place in a hierarchical manner, all the stages of healing are always present at all times in a healing wound because the healing potential is not the same throughout the wound. Wound contraction, which is facilitated by myofibroblasts, may not seem very prominent in extraction sockets, yet it very often happens in wounds that lack keratinization. What is important to note is that the greater the wound space, the more granulation tissue will be required by the wound in the secondary healing phase, which results in faster repair potential and more scar formation. However, the extraction socket is an exception to this rule.

Remodeling and maturation

This process is the longest-lasting phase of wound healing, taking up to a year after proliferation ends. The duration of proliferation is closely related to the volume and function of the tissues. Proliferation takes longer in tissues with a thick phenotype than in those with a thin one. Downregulated mechanosensory signals during remodeling reduce the cellular activity, terminating intercellular matrix formation and the extermination of myofibroblasts (a type of cell between a fibroblast and a smooth muscle cell, narrowing the wound area) through apoptosis.

The final phase of wound healing typically comprises the formation of a tensile, sensitive scar tissue with random collagen fibers. However, a scarless type of tissue mimicking the histologic properties

of intact connective tissue is formed during the wound healing process in certain intraoral areas such as the hard palate. Nonetheless, molecular bases of this type of healing that occurs without leaving a scar still remain to be elucidated.

Wound healing is completed by the end of the maturation period, and no alteration in the size of the newly formed tissue should be anticipated. Factors prevailing in the individual phases of wound healing are the main determinants of how rapidly and uneventfully this final stage can be achieved.

TYPICAL CHARACTERISTICS OF ORAL MUCOSAL WOUND HEALING

It is well established that oral mucosa wounds heal rapidly without leaving any complications or scars. Both cellular and intercellular substance as well as collagen fibers are arranged irregularly when a scar is formed, resulting in low matching with the neighboring tissue properties. Studies on healing models of oral mucosa in pigs and rodents have demonstrated that healing is more rapid and clinical, and histologic scar formation is less, when compared with similar skin injuries. However, the reason for the difference in healing between the skin and the oral mucosa is still unclear. It has been suggested that slow wound closure resulting in low-quality healing of the connective tissue and scar formation is inhibited by evolutionary selection to protect the tissue from microbial infections. In other words, since any delay in wound healing in the oral cavity may lead to difficulties in eating and the disablement of the organism, it can be speculated that oral mucosa has acquired faster and improved wound healing properties compared with the skin in the evolutionary development process.

Furthermore, studies have also suggested that improved wound healing properties of the oral mucosa do not solely originate from peripheral therapeutic opportunities offered by the oral environment, and that signals transmitted by the intercellular substance, which play

an important role in regulating cellular functions, are different from those of the skin.

Other mechanisms enabling the tissues to heal without scar formation include continuous bathing of the oral mucosa with saliva and strong inflammatory response. Saliva contains cytokines (i.e. cell-to-cell communication molecules) supporting wound healing, and growth factors such as epidermal growth factor (EGF), transforming growth factor beta (TGF- β), and insulin-like growth factor (IGF). Delayed intraoral wound healing where there is insufficient saliva supports this hypothesis. However, the influence of saliva on scar formation is not yet clearly understood.

On the other hand, it should be borne in mind that infection-free healing, atraumatic surgical techniques, and uncompromised systemic health are as effective as the basic biologic mechanisms in wound healing.

WOUND HEALING AND SYSTEMIC FACTORS

Systemic factors are as effective as local factors for uneventful and scar-free wound healing. The following discussion covers some systemic factors that have been selected due to their significance and prevalence, although this is not an exhaustive list.

Age

Aging is a natural life process associated with anatomical, biochemical, and physiologic alterations in all systems of the human body. Aging by itself does not affect the healing of intraoral wounds. However, chronic diseases acquired due to aging, medications, and drug-drug interactions may have an adverse effect on wound healing. In addition, dementia may occur at advanced ages, which together with malnutrition has an adverse effect on the healing process. Other factors that influence healing are lax adherence to prescribed drug regimens and poor oral hygiene.

Nutrition

Nutrition does not usually have an effect on wound healing in healthy individuals as it would, for example, in those with malnutrition induced by systemic disease. However, the availability of sufficient protein, zinc, and vitamins (A, B, and C) during the recovery of the body's immunity, which declines immediately following an injury, can support cellular activity and secure the required collagen synthesis at the wound site. However, malabsorption due to gastrointestinal diseases (e.g. Crohn's disease, ulcerative colitis, gastritis, or prolonged use of proton pump inhibitors) may result in malnutrition, leading eventually to a deficiency of essential vitamins and minerals as well as soft and/or hard tissue healing problems.

Dehydration

Electrolyte imbalance resulting from fluid loss or reduced intake may cause cardiac and renal dysfunction as well as functional disorders of the cellular metabolism, the oxygenation of blood, and hormonal activities. It is therefore recommended to inform patients regarding possible risks of dehydration in wound healing.

Diabetes

Certain chronic systemic diseases adversely affect the magnitude and quality of post-injury tissue response by modulating the hematopoietic system, while others modulate the endocrine system. In this context, diabetes has a special clinical significance. In 2019, the International Diabetes Federation (IDF) announced that there were 463 million people with diabetes globally, ranging in age from 20 to 79 years (according to the IDF Diabetes Atlas). This figure is expected to rise to 700 million by 2045. It is estimated that almost half (49.7 %) of diabetic patients have not yet been diagnosed.

In 2019, approximately 4.2 million adults aged 20 to 79 years were estimated to die as a result of diabetes and its complications. Also in this year, annual global health expenditure on diabetes was estimated

have been USD 760 billion. It is projected that expenditure will reach USD 825 billion by 2030, and USD 845 billion by 2045. New estimates of the prevalence of diabetes show that health expenditure worldwide due to diabetes and diabetes-related deaths will continue to pose a huge social, financial, and health-system burden. In the light of this, the significance of diabetes for patients seeking dental treatment is clear. Detailed information on diabetes, its importance in dental surgery procedures, and related issues that need to be taken into consideration is available in other sources. However, it is worth mentioning that wound healing may be impaired if the blood glucose level is not controlled. Glycemic control is achieved by measuring the blood glucose level and glycosylated proteins. Even in non-diabetic individuals, the blood glucose level may vary during the day, and it may fluctuate 10 times more in uncontrolled diabetic patients. Also, the blood glucose level only indicates the glucose level at the time of analysis, but gives no information about how well it is being maintained. On the other hand, the glycated hemoglobin (HbA1c) assay, used for the follow-up of diabetic patients, can provide information about the patient's glucose level over a period of about 3 months. However, considering that the HbA1c assay covers a specific timeframe, and that wound healing is initiated simultaneously with surgery, it is advisable to recognize the patient's blood glucose level in addition to the HbA1c assay at the start of an extensive surgery.

Furthermore, complications in the other organ systems of diabetic patients may also provide information regarding the potential of wound healing. Since dental tissue can be deemed terminal tissue, particular attention to circulatory abnormalities seen in similar terminal tissue/organs would facilitate the planning of appropriate treatment. For instance, micro- or macro-angiopathy in a diabetic patient may indicate the likelihood of impaired wound healing. It should be borne in mind that retinal examination is a common diagnostic method for angiopathies, and the treating physician should be contacted, if necessary.

Previous studies have suggested an increase in the incidence of osteoporosis in diabetic patients. Human and animal studies have also shown that the reduction in bone mass of type 1 diabetic patients is

induced by elevated alkaline phosphatase levels and decreased vitamin D₃, parathyroid hormone, and osteocalcin levels as well as intestinal calcium absorption impairment and excessive urinary hydroxyproline excretion. Insulin increases the collagen synthesis and osseous ingestion of amino acids. A decreased release of IGF-1 may contribute to the development of diabetic osteoporosis. In addition, malnutrition and a sedentary lifestyle may lead to osteoporosis in diabetic patients.

Nicotine intake

This section is headed 'nicotine intake' rather than 'smoking' or 'tobacco use' because most smokeless or electronic cigarettes commonly used in the cessation of smoking also contain nicotine. Chronic nicotine intake has an adverse effect on wound healing. Several studies have demonstrated that the wound healing potential of smokers is impaired and that their immune response functions less effectively than in nonsmokers. Nicotine intake results in vasoconstriction of the peripheral vessels, adversely affecting blood supply to the tissues. Chronic nicotine intake affects the organism in a dose-dependent manner. Furthermore, when inhaled, all components of nicotine are in contact with the surface of the oral cavity and also with the wound. Therefore, when tailoring surgery, it is of the utmost importance to recognize the patient's daily dose of nicotine intake.

Although it is considered helpful for patients to cease nicotine intake prior to surgery and not to resume for a while afterwards, this temporary measure only mitigates but does not eliminate the associated problems because nicotine metabolites survive 2 to 24 hours in blood. In this context, the following practical tip may offer benefits from this effect, albeit to a limited extent: Patients should be advised to discontinue nicotine intake at least 24 hours (half-life of metabolites) before the surgical procedure, and resume nicotine intake no earlier than 24 hours after the completion of the procedure (phases of wound healing), but as late as possible, and attempt to keep the daily nicotine dose as low as possible during wound healing.

Diseases and/or therapies affecting the host defense mechanism

Since immune response protects the patient from infections, the outcome of the surgical procedure is severely jeopardized if the immune system is suppressed. Patients infected with human immunodeficiency virus, those receiving chemotherapy, radiotherapy, hemodialysis or a high dose of catabolic steroids, or patients with an organ transplant, may suffer immune response deficiency or disorders. Note that certain patients may be sensitive to certain suture materials, latex, or metal instruments.

DRUGS AND WOUND HEALING

Antithrombotic therapy

mechanism: anticoagulants and antiplatelets. Coagulation, which is the initial step of wound healing, is executed by coagulation factors. Oral anticoagulants inhibit the coagulation factor synthesis. Antiplatelet agents, also called antiaggregants, affect coagulation by modifying the aggregation properties of platelets. Antithrombotic therapy is used to reduce the risk of thromboembolism. Antithrombotic agents are mainly used for the prevention of coagulation or the enlargement of venous clots. Oral anticoagulants are often used to prevent venous thrombosis, and antiplatelets are mainly used in arterial occlusive diseases. Two widely used antiplatelet agents are acetylsalicylic acid, which is a cyclooxygenase inhibitor, and clopidogrel, which is an adenosine diphosphate receptor antagonist.

Anticoagulants comprise vitamin K inhibitors such as warfarin or factor Xa inhibitors such as heparin. Novel oral anticoagulants include dabigatran, rivaroxaban, apixaban, and edoxaban.

Since difficulties encountered in the formation and preservation of the fibrin plug in patients using these drugs may complicate wound healing, special measures may be required for closing and subsequently protecting the wound.

Antiangiogenic agents

Angiogenesis is the formation of new blood vessels in existing vascular structures. Antiangiogenic agents inhibit the development of existing blood vessels or the formation of new ones. Although these agents were originally developed to block the blood supply to tumors in the treatment of cancer, currently they have also been widely used in the treatment of other vascular diseases. A new vascular network starts to form on the third day of wound healing, supplying oxygen and nutrients to the wound site. Antiangiogenic agents downregulate this mechanism and adversely affect the wound healing process. However, these adverse effects are not the same for every patient population.

Antiresorptive agents

Antiresorptive treatment aims to decrease the rate of bone resorption. It mainly exerts its effect by blocking osteoclastic activity, thus bone mass is preserved. However, the biologic activity of osteoblasts is very limited without osteoclasts, which utterly affect the bone turnover. These agents are mainly used for the treatment of osteoporosis in postmenopausal women and to prevent metastasis among oncologic patients.

Drugs inhibiting bone resorption include estrogen, selective estrogen receptor modulators (tamoxifen, raloxifene, lasofoxifene), calcitonin, bisphosphonates (alendronate, risedronate, ibandronate, zoledronic acid), monoclonal antibodies such as denosumab, ipriflavone, tibolone, vitamin D and active metabolites, and calcium. These drugs also delay wound healing due to their antiangiogenic effects.

Corticosteroids

Corticosteroids have a wide spectrum of use, including treatment of rheumatic and non-rheumatic diseases and conditions. They exert a strong anti-inflammatory and immunomodulator effect. The use of

corticosteroids induces anti-inflammatory proteins; it also inhibits cytokine secretion and chemotaxis. Furthermore, it is associated with fibroblast dysfunction and reduced collagen generation, angiogenesis, and reepithelization, critical components of the wound healing process, which would be impeded by their absence. Commonly used corticosteroids include prednisolone, triamcinolone, betamethasone, dexamethasone, and hydrocortisone.

LOCAL FACTORS AFFECTING WOUND HEALING

Direction and length of incision

A properly planned incision should be long enough to provide adequate visualization. Short incisions may cause injuries and blood supply deficiencies that result from the rupture of wound edges due to overstretching and pressure on the flap to improve visibility. This, in turn, adversely affects wound healing.

Planning incisions in a way that allows for a larger mucoperiosteal flap base is crucial for the nutrition of the flap. Special care should be exercised when performing the incision to preserve the integrity of capillaries advancing from the base of the flap. Incisions should always be planned in a way that leaves a margin of intact tissue, both mesial and distal to the surgical site, and they should not pass through the papillae or areas where the tissues are thin (Fig 1-1).



Fig 1-1 The incisions should not be placed at sites with a low regeneration potential such as the papillae, or on thin tissue such as the zenith of the clinical crown. There should be a 90-degree angle where the incisions meet the gingival margin. The releasing incisions should be placed at a safe distance from the adjacent gingival margin and there should always be intact bone underneath. The base of the flaps should be wider so as not to cut the vessels and to prevent the blood supply to the elevated flap.

The following principles should be followed when planning the direction of the incision:

- The natural direction of healing of a surgical wound is side to side, not end to end.
- Tissue fiber arrangement in the area to be incised and dissected varies according to the type of tissue. The optimal cosmetic result can only be achieved by making the incision parallel to the tissue fibers. However, the result may vary depending on the tissue layer incised.

Surface angle of incision

Care should be exercised to incise the tissues smoothly with a single stroke of the scalpel. Placing the scalpel perpendicular to the mucosal surface facilitates maximum adaptation of wound margins without tapering and creating dead spaces, thereby leading to maximum perfusion. This would result in the fibrin layer between the wound edges being as thin as possible, allowing fluid exchange between these edges (Fig 1-2).

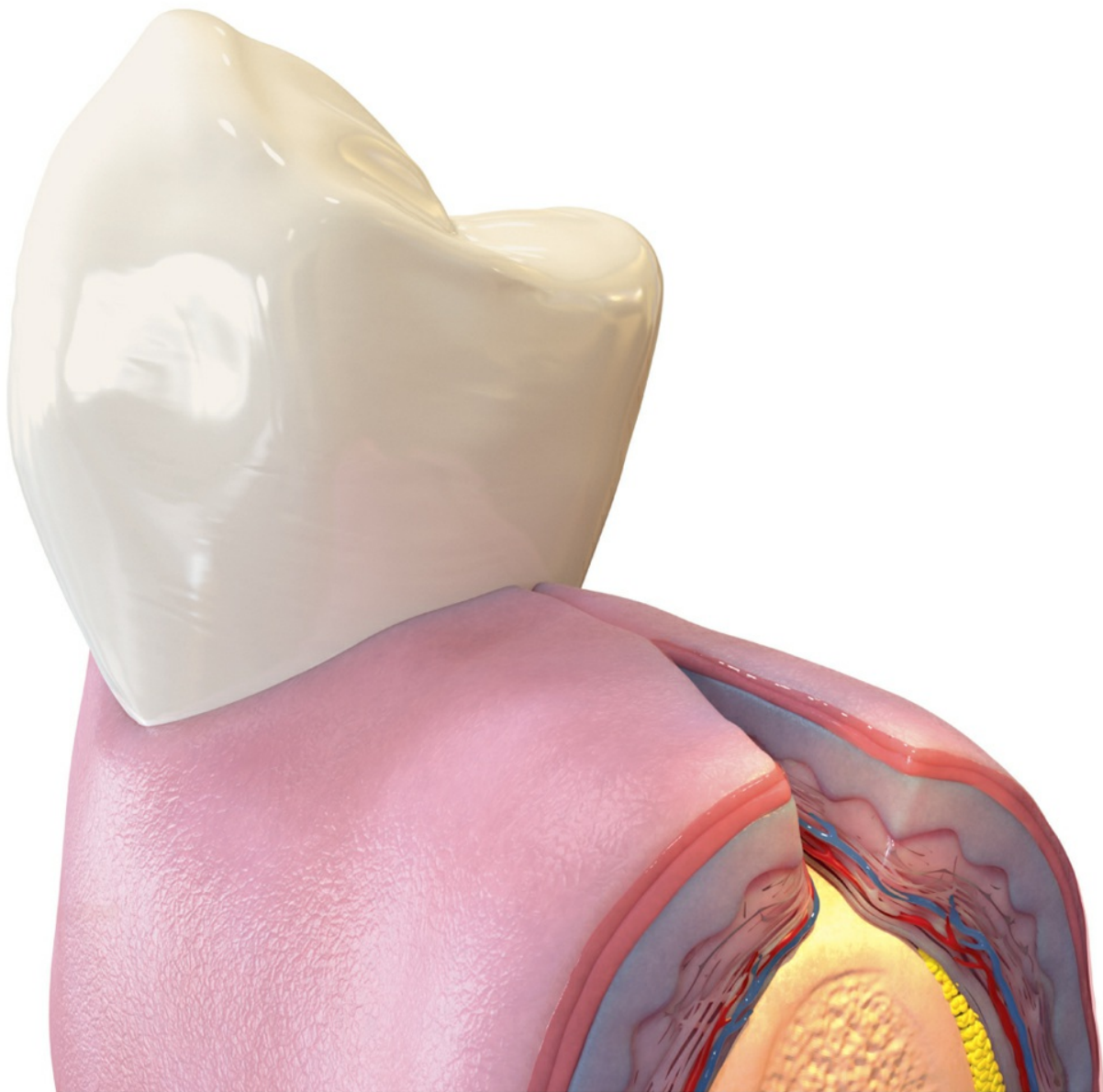


Fig 1-2 Blades should be held perpendicular to the mucosal surface in order to prepare clear-cut wound margins, facilitating uneventful healing.

Hemostasis

There are various mechanical, thermal, and chemical means to control blood and fluid flow at the wound site. Hemostasis enhances the visibility for the surgeon and minimizes the risk of human error. Failure to control bleeding from dissected or punctured blood vessels or from periosteal tissue that is not clearly elevated results in limited visualization of the surgical site. Complete bleeding control before wound closure prevents the formation of postoperative hematoma. Accumulation of blood or serum at the incision site further hinders the approximation of the wound edges and provides an ideal environment for the growth of microorganisms, leading to infections. Therefore, mild pressure with a wet gauze should be applied on the surgical site following wound closure to help control fluid accumulation. However, in cases such as guided bone regeneration (GBR), where it is imperative to preserve the space for hard tissue growth under the membrane, care should be taken not to press down and collapse the space under the membrane.

Tissue moisture control

Rinsing the wound with lukewarm sterile saline solution on a regular basis during prolonged surgical procedures or covering exposed surfaces with gauze patches soaked in sterile saline solution aids the healing by preventing tissue dehydration.

Removal of necrotic tissue and foreign bodies

The complete removal of all necrotic tissue and foreign bodies that are impossible for the body to resorb is crucial for uneventful wound healing. The presence of foreign bodies such as dust, metal, calculus

or filler remnants increases the risk of infection. The removal of tooth and tissue residuals that cannot receive blood supply from the wound accelerates healing.

Prevention of dead space in wounds

The accumulation of fluid, blood, air, foreign bodies or dead tissue residuals between the tissue layers results in dead space in wounds, which in turn leads to the formation of a thicker fibrin layer, resulting in insufficient perfusion. It also enables the hosting of microorganisms. A drain can be placed to prevent this situation, which may occur upon completion of the surgical procedure. An alternative is to apply compression with a wet gauze patch at the wound site, when necessary. However, compression should be applied with caution when GBR is used, since this technique aims at preserving a space under the membrane.

Tissue tension

Over-tensioning of tissue to the extent of disrupting circulation endangers blood supply, which adversely affects wound healing. In addition, the tensioned suture may tear the tissue itself because of the buildup of swollen tissue due to postoperative edema. Special care should therefore be exercised to ensure that measures taken to release tension do not jeopardize blood supply. Consequently, the impact of releasing incisions or periosteal incisions made on the blood supply of the wound site should be considered. Furthermore, the closing of wounds covered by approximated or displaced tissue merely through the use of simple sutures leads to circulatory impairment caused by suture tension on the wound edge. It is therefore recommended to place the sutures (see mattress sutures, page 56) approximating wound edges away from the margin where the healing process would take place, and to place additional sutures at the wound edges.

Infection

Preventing invasion of the area by microorganisms during wound healing allows the tissues to concentrate their entire biologic potential on closing the wound. The presence of an infection impairs wound healing and reduces healing quality due to chronic irritation caused by the infection. It should be borne in mind that an infection involving other parts of the oral cavity also increases the microbial load and affects the closure and healing of the wound. Therefore, an attempt should be made to reduce the microbial load of the mouth prior to the surgical procedure and to keep it under control by resuming oral hygiene as soon as possible after the intervention.

Wound and clot stabilization

Given the fact that mobile tissue cannot heal, measures should be taken to stabilize and fix the wound margins and/or areas in order to ensure proper healing. Such measures should start with clot stabilization. The thicker the clot that forms immediately after the intervention, the thicker the temporary intercellular substance will be. Hence, the distance between the wound margins would increase, leading to insufficient intercellular fluid transport. As a precautionary measure against this, it is reasonable to apply pressure with a wet gauze dressing immediately after the process. The applied pressure would control the thickness of the clot layer while allowing the clot to form by stabilizing the tissues, albeit briefly. However, if bone augmentation has been performed, the applied pressure should not adversely affect the circulation or cause tissue contusion, nor should it crush the augmented volume.

Blood supply to the wound site

Oxygen is essential for tissue vitality and thus for wound healing. The tissue heals faster on or around the neck and the face, which receives a good supply of blood, and heals more slowly on the limbs (i.e. distant organs and tissues). To facilitate blood supply and nutrition of

the tissues, an evaluation of blood supply possibilities should be made when planning surgical incisions. It is also important to ensure that the technique to be used is compatible with atraumatic surgical principles.

Enhanced visualization

The aim of the atraumatic surgical technique is to achieve rapid wound healing while minimizing tissue damage. Although this technique is commonly interpreted as a minimally invasive one that minimizes the number of incisions made, having a better visualization of the operation site reduces the risk of damage to peripheral tissue. Additional pressure exerted or tissue tension created during the process of tissue retraction with a retractor may endanger blood and lymph circulation and damage the tissues. The resulting hematoma may increase the risk of proliferation of microorganisms. Furthermore, it is always possible to enhance the visualization of the site by using additional sutures (see view-enhancing sutures, page 67). In addition, well-planned and properly executed incisions can be made as they would not adversely affect healing.

In conclusion, sutures used during and after the surgical procedures should facilitate event-free healing of the wound. The phases of healing and factors that play a role in such phases should be utilized to ensure rapid and successful wound healing. Therefore, the surgeon should always be completely familiar with the materials and instruments to be used during the surgery.

Recommended reading

1. Broughton G, Janis JE, Attinger CE. The basic science of wound healing. *Plast Reconstr Surg* 2006;117(7 suppl):12S–34S.
2. Ghantous AE, Ferneini EM. Aspirin, Plavix, and other antiplatelet medications: what the oral and maxillofacial surgeon needs to know. *Oral Maxillofac Surg Clin North Am* 2016;28:497–506.

3. Guo S, Dipietro LA. Factors affecting wound healing. J Dent Res 2010;89:219–229.
4. Harper D, Young A, McNaught CE. The physiology of wound healing. Surgery 2014;32:445–450.
5. Larjava H. Oral Wound Healing: Cell Biology and Clinical Management. Wiley-Blackwell, 2012.

CHAPTER 2

**SUTURE MATERIALS AND SUTURING
INSTRUMENTS**



Having a good understanding of the properties of suture materials and suturing instruments facilitates decision making regarding specific operations and increases the success of the surgeon and the procedure. What follows in this chapter is an overview of the requirements for successful surgical suturing.

SUTURE THREADS AND NEEDLES

Sutures comprise two main components, namely the thread and the needle.

It is impossible to suggest suture materials that fit all purposes as the choice should take into consideration the characteristics of the tissues and of the materials as well as the requirements of the technique to be applied.

The following tissue characteristics and conditions should be taken into consideration:

- Physical characteristics or consistency of the tissues to be sutured.
- Biologic properties of the tissues.
- Health status of the tissues.
- Proximity of the tissues.

The decision regarding the requirements of the technique should be based on the question of which of the following procedures needs to be applied:

- Repositioning of the tissues or approximation of wound edges.
- Wound closure.
- Hemostasis.
- Enhanced visualization.

PHYSICAL PROPERTIES OF SUTURE THREADS

Currently, a wide range of suture threads of various physical and/or biologic properties are available on the market, most of which were originally manufactured for the textile market and then used for surgical purposes. Since the physical and structural properties of surgical suture threads are decisive for the purpose and area of their use, the considerations in the following paragraphs should be taken into account.

Gauge

Gauge refers to the diameter of the suture thread. Common surgical practice is to use a suture thread with the smallest diameter that is capable of keeping the healing tissues in place. Thus, the trauma the suture thread will cause when passing through the tissues is minimized.

Moreover, the chosen suture thread should be thinner than the tissues, i.e. the tensile strength of the suture should be lower than that of the tissues to ensure that the thread is broken before the tissues are ruptured (Fig 2-1).

Thread and needle gauge

- 3-0 Thick and coarse tissues
- 4-0 Suitable for general use, good for flap surgery
- 5-0 Thick grafts and thin flaps
- 6-0 Connective tissue grafts and cosmetic surgery
- 7-0 Repair of split-thickness flap and Schneiderian membrane or other gentle tissues

Fig 2-1 Diagram summarizing the correct thread and needle gauge for specific tissues. The principles to bear in mind are: 1) If something is going to break, it should be the thread rather than the tissues; and 2) Thin thread should be selected for thinner tissues, and thicker thread for thicker tissues.

The diameter of suture thread is stated numerically in accordance with the United States Pharmacopeia (USP) and European Pharmacopeia (EP) (Table 2-1). The USP system is more commonly used.

Table 2-1 The diameter of suture thread is stated numerically in accordance with the United States Pharmacopeia (USP) and European Pharmacopeia (EP)

--

USP	EP	Suture thickness [mm]
12-0	0.01	0.001–0.009
11-0	0.1	0.010–0.019
10-0	0.2	0.020–0.029
9-0	0.3	0.030–0.039
8-0	0.4	0.040–0.049
7-0	0.5	0.050–0.069
6-0	0.7	0.070–0.099
5-0	1	0.10–0.149
4-0	1.5	0.15–0.199
3-0	2	0.20–0.249
2-0	2.5	0.25–0.299
	3	0.30–0.349
0	3.5	0.35–0.399
1	4	0.40–0.499
2	5	0.50–0.599
3+4	6	0.60–0.699
5	7	0.70–0.799
6	8	0.80–0.899
7	9	0.90–0.999
8	10	1.00–1.099
9	11	1.10–1.199
10	12	1.2–1.299

As the number of the suture thread increases, its diameter decreases, i.e. 5-0 thread is thinner than 4-0 thread. A reduction in the thickness of the suture thread also refers to a reduction in its tensile strength. As the suture thread becomes thinner, auxiliary instruments such as suture holders and scissors should be chosen accordingly.

Physical structure

The structure of suture thread depends on the number of strands used in its production. Suture threads may be of a monofilament or multifilament structure. Monofilament threads comprise a single strand and feature a hostile environment for microorganisms, since they have a smooth surface with no retention areas. Their drawbacks are low knot-holding security and shape memory. Multifilament threads are made by twisting or braiding multiple strands (Fig 2-2a and b), which makes them easier to use during suturing and knot tying. Their disadvantage is that they facilitate the accumulation and proliferation of microorganisms. They are therefore not suitable for use in areas subject to microbial contamination or where there is a risk of infection. Furthermore, the tissue passage properties of multifilament threads may degrade due to blood clotting on the surface during prolonged suturing. This blood should be wiped off with a wet gauze patch. Suture threads may swell due to the absorption of ambient fluid, in which case their knots may become loose.



a



b



Fig 2-2 (a and b) Single-strand monofilament sutures (a) have several advantages such as smooth tissue passage. On the other hand, braided sutures provide improved knot stability (b).

Capillarity

This property refers to the absorption and transmission of fluid by the suture thread along its entire length. Suture threads that have capillarity allow for the transmission of microorganisms between the interior and exterior of the wound, leading to contamination. Capillarity is a more evident feature in braided compared with monofilament threads. The surface of some monofilament threads is coated with wax, silicone, polytetrafluoroethylene (PTFE) or polyester to minimize the effects of this feature.

Tensile strength

This is a measurement calculated by dividing the force that stretches and breaks a suture thread by the cross-sectional area of that thread, which is directly proportional to the diameter of the thread. This coefficient gradually decreases in absorbable sutures, once the suture contacts the tissues. This decline in the tensile strength of absorbable sutures is not directly proportional to the rate of absorption and may vary depending on the suture thread material. However, tensile strength is directly proportional to the diameter of the suture thread. The weakest point of a suture is its knot. A tied suture thread is weaker than an untied one.

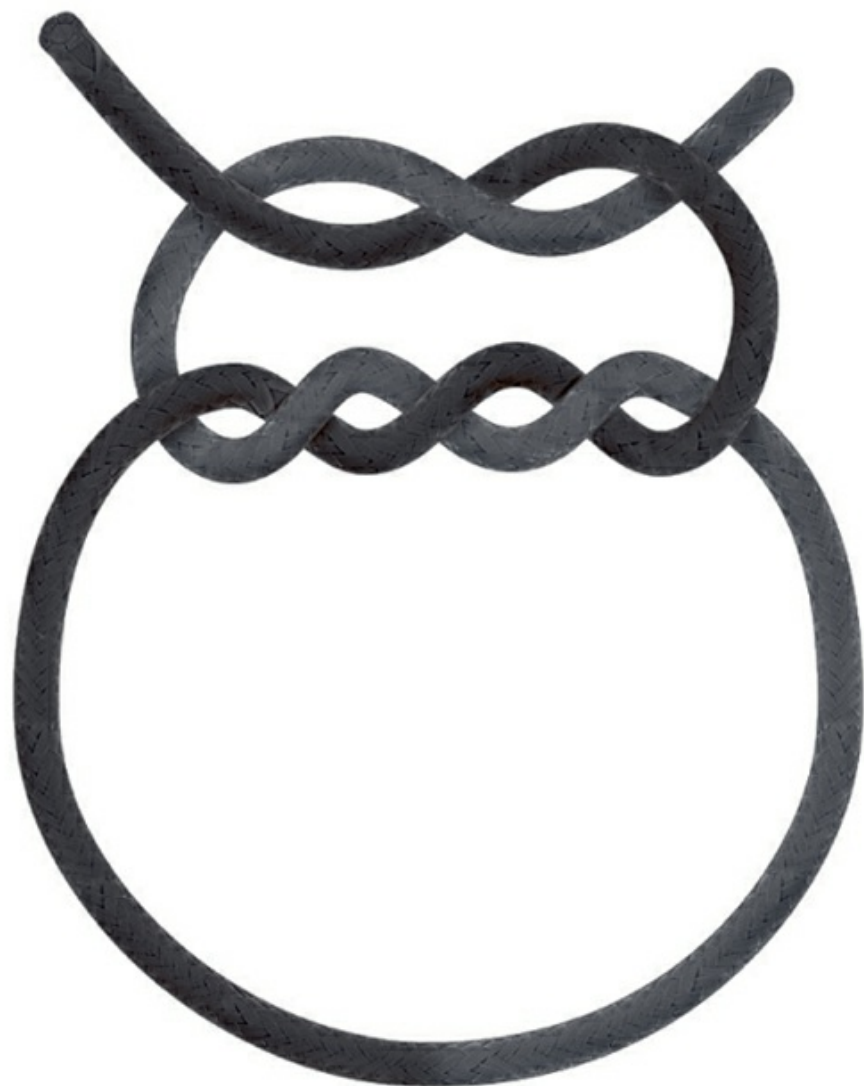
Tissue passage

The glide of a suture thread is directly proportional to its coefficient of friction. The coefficient of friction indicates the level of lubricity of the

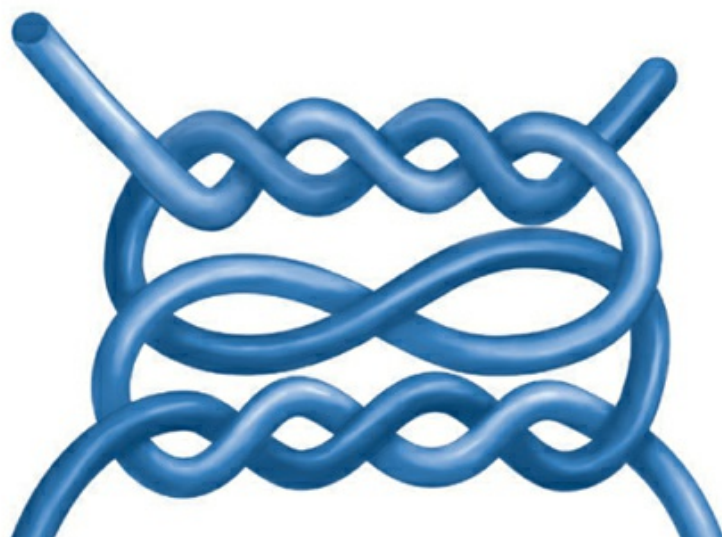
suture thread. It is more difficult for multifilament sutures, which have a high coefficient of friction, to pass through tissues. Multifilament sutures therefore tend to cause more tissue damage, both during suture placement and removal. A larger surface area of multifilament sutures results in blood clotting on the surface during prolonged suturing, further increasing the already high coefficient of friction. In such cases, wiping the suture with a wet gauze patch facilitates the operation.

Knot-holding security

This depends on the pliability and shape memory of suture threads. It is easier to fasten a knot with threads that are easily pliable and have a low shape memory. Knot-holding security is the resistance of the knot against forces leading it to slip, either in part or entirely. The knot-holding security of monofilament sutures is low, resulting in the knot loosening more easily after it is locked. There are two ways to avoid this loosening in a monofilament thread: 1) Ensure that the knots rest on the soft tissue instead of being suspended between the wound margins; and 2) Tighten the first knot with an additional knot tied in the same direction as the first knot (Fig 2-3a and b). Typically, this additional tightening is highly restricted and can only recover a part of the loosening. Making the knot overtight does not improve knot security; instead, it endangers blood circulation.



a



b

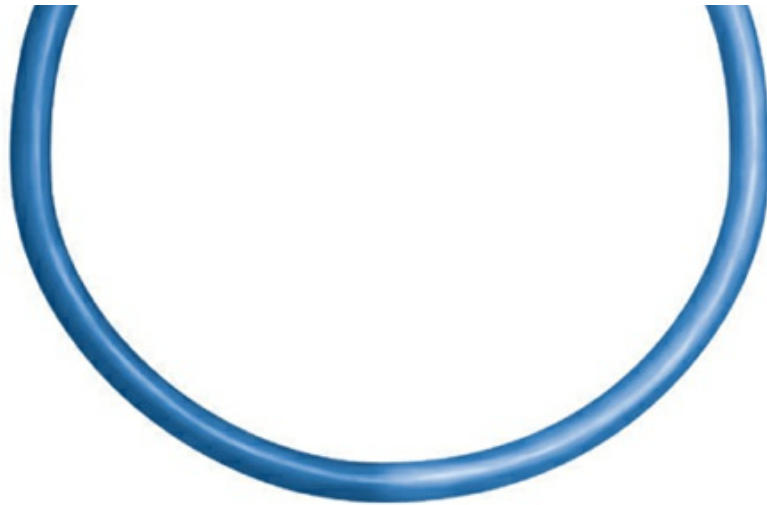


Fig 2-3 (a and b) A surgical knot using a multifilament suture thread with low shape memory should be fastened by a single twist spiral knot tied in the opposite direction on a double twist spiral knot fastened in a particular direction (a). To tighten the first knot fastened with a monofilament thread with high shape memory that tends to loosen, a single twist spiral knot tied in the same direction with the first knot should be made with a view to recovering the loosened part of the double spiral twist knot prior to locking. A final reverse knot should be made to lock the knot (b).

Elasticity

This property refers to the ability of suture thread to regain its original form and length following the pulling force applied during the operation. Sutures with high elasticity can resume their original size following deflation of postoperative edema, keeping wound edges intact without being separated. Most non-absorbable sutures exhibit this property.

Shape memory

This refers to the tendency of suture thread to resume its original form following the deformation occurring after a knot is tied. High-memory sutures are more durable in maintaining their shape; they preserve

their original packaged form and offer less knot-holding security. In particular, monofilament sutures have high shape memory. Another characteristic of these sutures is that their ears irritate adjacent tissues when cut short. To avoid this problem, it is recommended to retain longer ears in suture threads with high shape memory (Fig 2-4).

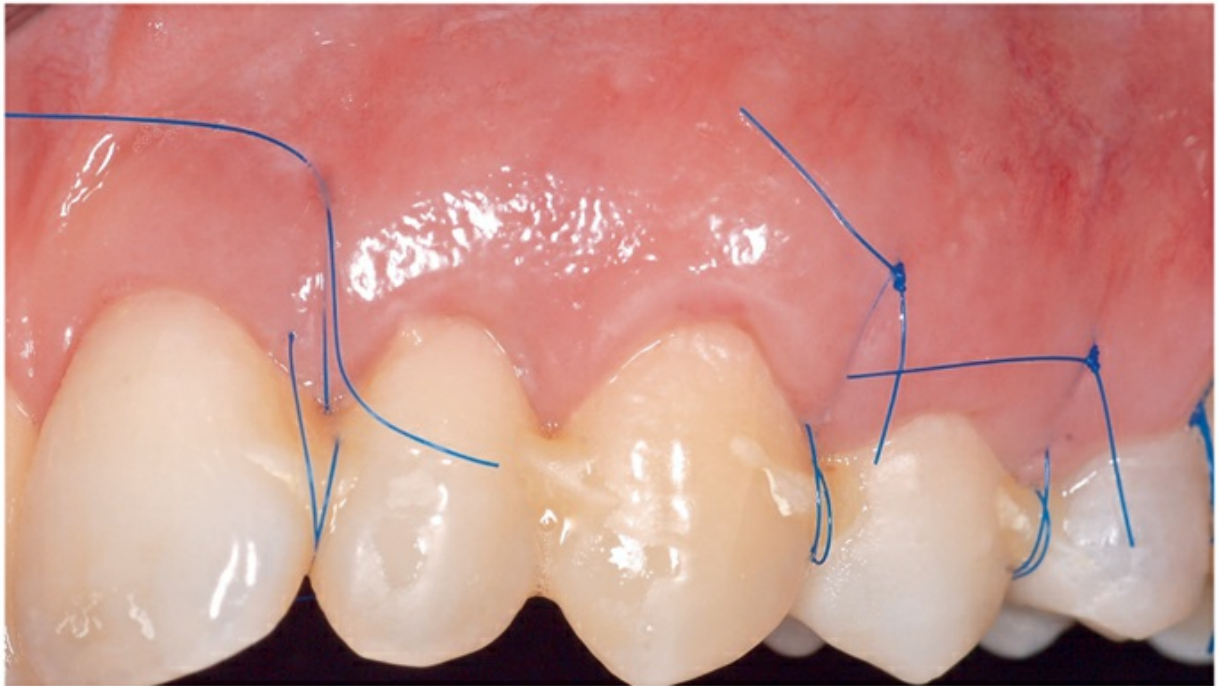


Fig 2-4 Since they preserve their plasticity, high-memory sutures tend to irritate the surrounding tissues. Damage to these tissues can be avoided by leaving the ears long, as shown in the photograph.

In conclusion, no individual suture thread is ideal for all circumstances. For instance, a suture thread to be used after hard tissue augmentation should have a smooth tissue passage and low capillarity with minimal tissue reactivity. In such a case, a monofilament thread would be indicated. However, such properties would be entirely useless for a suture to be placed for bleeding control, where the main property required is knot-holding security.

ABSORPTION CHARACTERISTICS OF SUTURE THREADS

on their material of manufacture, namely absorbable suture threads that can be totally dissolved by the tissues and non-absorbable suture threads that cannot be absorbed at all.

Absorbable sutures usually lose their tensile strength within 60 days, whereas non-absorbable sutures endure for a longer period of

synthetic types.

All threads may cause inflammation and a wide range of other tissue reactions of varying degrees. Inflammation reduces the resistance of the body against infections, delaying the healing process. Non-absorbable sutures may lead to negligible tissue reactivity. Tissue reactivity caused by absorbable sutures is associated with the absorption mechanism of the material. Natural materials dissolved by enzymes in which proteins are absorbed through proteolysis are more often associated with inflammatory reactions, whereas synthetic products absorbed through hydrolysis result in less tissue reactivity.

Although tissue response to suture threads is an important issue, it is not long lasting. Ultimately, the method of wound closure is the key factor, i.e. whether the wound is healed with primary intention or not is of the utmost importance (Fig 2-5a to c).

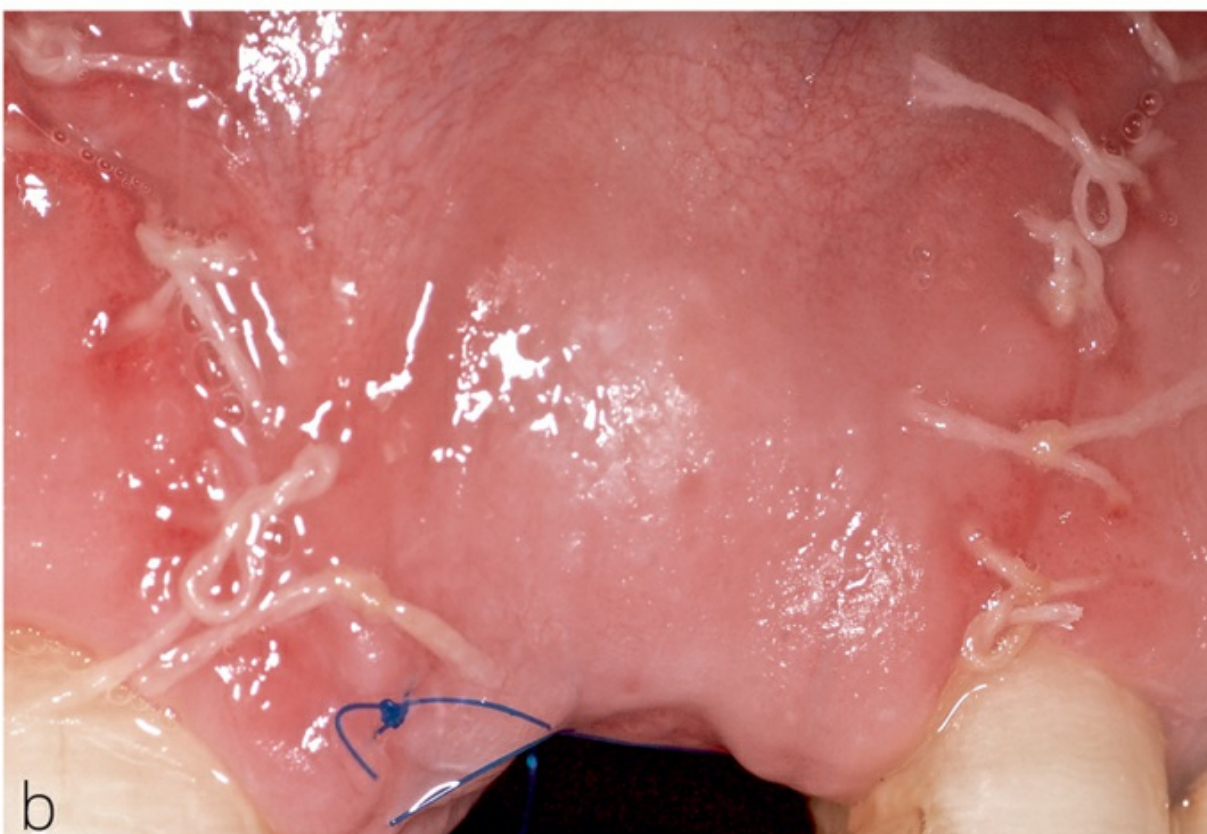
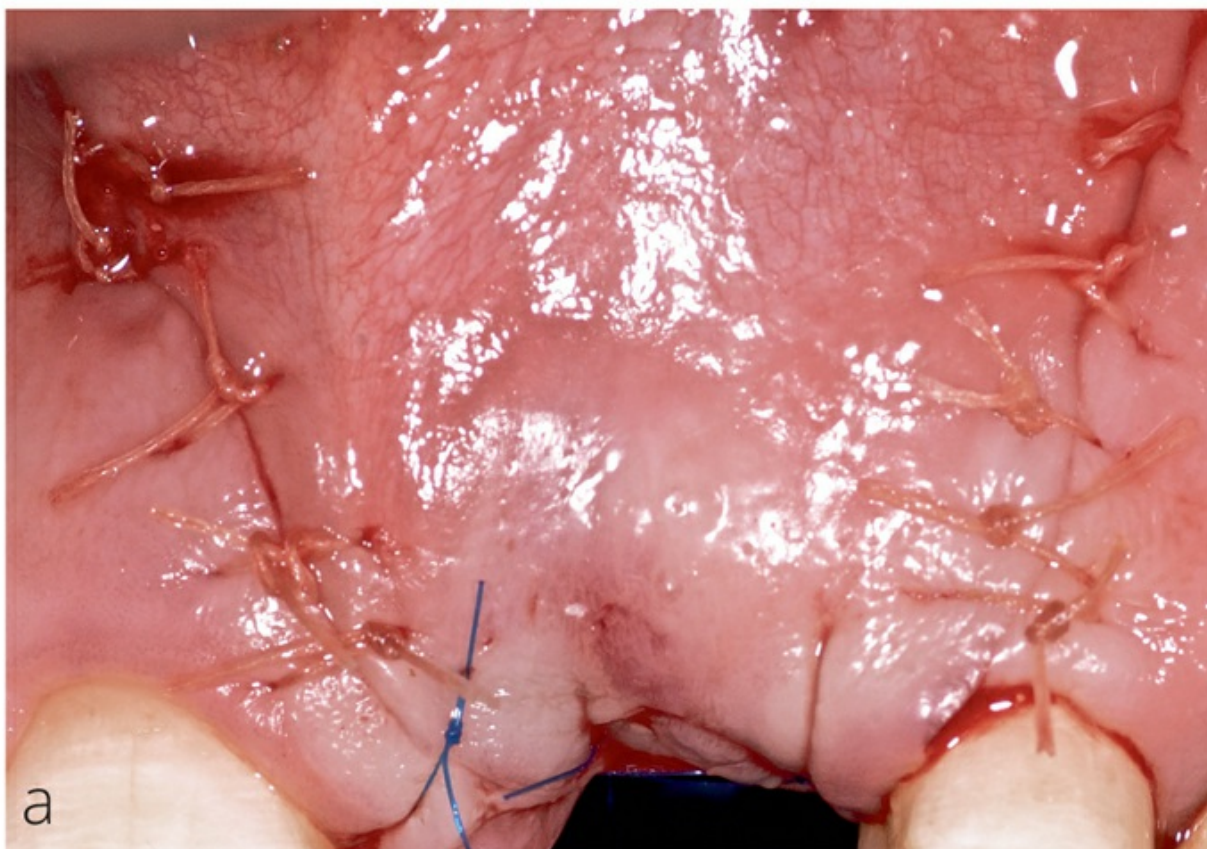




Fig 2-5 (a to c) Although tissue response to absorbable and non-absorbable sutures is different in the short term (a), this discrepancy disappears in later phases of wound healing (b), and at the end, the defect resulting from poor wound edge approximation lasts longer than the one possibly created by the tissue material (c).

ABSORBABLE SUTURE THREADS

Suture materials are absorbed by tissues through two different mechanisms: The first is enzymatic degradation or enzymolysis, which is the metabolization of suture material through the inflammatory response of the tissues. The second is hydrolyzation, which is the dissolution and cleavage of the polymer chains of the suture by the addition of water. Naturally, hydrolyzation does not lead to tissue inflammation. Catgut sutures manufactured from the intestines of

ruminants are dissolved through enzymatic absorption, whereas all synthetic sutures are dissolved through hydrolysis. Although some tissue reactivity results from the hydrolyzation of suture threads, it is negligible compared with enzymolysis.

Although the use of absorbable threads was initially limited to sutures that are impossible or difficult to remove, they are currently used in a wider range of procedures and applications. In recent years, they have been used for patients traveling long distances in order to eliminate the need for a second visit, to minimize the risk of contagious diseases, and to avoid undue patient stress in cases requiring anesthesia for suture removal or in pediatric cases. However, in general, non-absorbable suture threads should be the first choice when suture removal does not constitute a problem technically, medically or socially, since the prolonged absorption process may cause the suture to stay in its place, leading to excessive microorganism accumulation.

Absorption of suture threads results in a reduction of their tensile strength. Half-life is the term for the period of time in which a thread loses half of its tensile strength. It is one of the main criteria for the evaluation of absorption. Dissolution, on the other hand, is the period required for complete destruction of the thread. There are numerous variable factors affecting the duration of these periods, including but not limited to thickness of the suture thread, tissue type (i.e. catabolic processes work slower in some tissues), pH of the conditions (i.e. absorbable sutures are hydrolyzed faster in an alkaline environment), the circumstances of the environment in which the thread is used (i.e. temperature, infection, etc), and the overall health of the patient (i.e. the presence of diseases complicating wound healing). Although the rate of absorption is important for many complications resulting from suture threads, the rate of loss of tensile strength is also critical as a guarantee for keeping the wound closed during healing. Consequently, absorbable suture threads should be chosen based on the rate or time of absorption and the rate or time of loss of tensile strength. Therefore, in addition to their physical properties, the half-life of absorbable suture threads should also be considered.

Absorbable natural suture threads

Catgut was the first suture material to be used that could be absorbed by tissues. Catgut threads are obtained from the intestinal collagen of sheep or cattle. Some manufacturers package these products in an alcohol solution to retain their flexibility and prevent desiccation and breakage. Three different types of catgut are currently available on the market, namely plain, chromic, and fast-absorbing, all of which are monofilament. Plain catgut causes a certain level of reaction in tissues and can maintain its full tensile strength for 7 to 10 days following surgery. It is completely absorbed by the end of 70 to 90 days. Chromic catgut is treated with a chromium salt solution to reduce the rate of absorption and tissue reactivity and to improve tissue passage properties. This type of catgut maintains its tensile strength for 10 to 21 days and is completely absorbed by the end of 90 days. Fast-absorbing catgut is heat treated for faster absorption and can maintain its tensile strength for only 5 to 7 days. It is completely absorbed within 2 to 4 weeks. However, in accordance with EU regulations, this type of catgut is no longer manufactured or used in Europe.

Absorbable synthetic suture threads

Polyglycolic acid

This was the first synthetic, absorbable suture thread to be manufactured. Monofilament and uncoated variations of this thread have a high tensile strength of up to 60 % on day 7, 35 % on day 14, and 15 % on day 28. This thread is completely hydrolyzed within 90 to 120 days. It is easy to use, with a high knot-holding security. However, its multifilament structure with insufficient tissue passage properties may cause tissue damage. Although it is not associated much with tissue reactivity, its multifilament structure promotes microorganism accumulation. There is also a version of this thread that is coated with polyacrylate to improve tissue passage and reduce microorganism retention. However, an additional knot is required to improve knot-holding security.

Polyglactin

Polyglactin was the second synthetic absorbable suture to become available. It is a coated, braided, multifilament suture like polyglycolic acid. This thread is manufactured from glycolic acid (90 %) and lactic acid (10 %), both natural materials that can be metabolized easily. A combination of lactide and glycolide forms a molecular structure, maintaining the tensile strength to approximate tissues safely in the critical phases of wound healing. The thread can be dissolved through hydrolysis in a similar way to all other absorbable synthetic threads. The hydrophobic properties of lactide prevent fluid from infiltrating into the fibers of the thread. This reduces loss of tensile strength in the biologic environment compared with natural absorbable threads subjected to enzymatic absorption. The thread is able to maintain 65 % of its tensile strength by the end of 2 weeks and 40 % by the end of 3 weeks. It is completely absorbed by the end of 60 days.

Poliglecaprone

Poliglecaprone is a monofilament absorbable suture material made of glycolide and epsilon caprolactone copolymer. This thread features superior pliability for easy handling and tying. It is one of the durable absorbable suture materials currently available, allowing for the selection of suture sizes that are one to two times smaller than would ordinarily be chosen. It is usually preferred for procedures requiring high initial tensile strength, since its tensile strength tends to decrease 2 weeks after surgery. Dyed versions retain 55 % and undyed versions retain 45 % of their tensile strength by the end of the first week postsurgery. Both versions are completely absorbed within 90 to 120 days.

Polydioxanone

Polydioxanone is a synthetic, absorbable, monofilament suture thread that is preferred in procedures where sutures need to remain in place for a prolonged period. It is absorbed very slowly through hydrolysis. On the one hand, the thread facilitates tissue passage with its smooth structure, but on the other hand it has the poorest knot security of all

the synthetic absorbable sutures. It retains 70 % of its tensile strength by the end of 2 weeks, 50 % by the end of 4 weeks, and 14 % by the end of 8 weeks. This retention of strength after implantation is an advantage compared with other synthetic absorbable sutures and is useful wherever extended approximation of tissues under tension is required. Absorption and hydrolysis processes would be halfway complete by the end of 90 days following the day of application and would be complete within 6 months.

NON-ABSORBABLE SUTURE THREADS

These threads do not undergo structural changes and mostly retain their original properties. Therefore, they are used only in situations where it is possible to remove them. Natural materials include stainless steel wire, silk, cotton, and linen. Non-absorbable synthetic threads, on the other hand, are made of polyamide, polypropylene, and polyester. They are used in cases where prolonged support is required for wound edges.

Non-absorbable natural suture threads

Silk

This is a multifilament thread made of protein fibers from silkworm larvae. Although it is typically considered to be a non-absorbable thread, it is metabolized in just over 2 years. It is recognized as the gold standard thanks to its superior handling qualities and high knot-holding security. It also has high capillarity. In addition, silicone or wax-coated versions are available to suppress its capillarity property. It was originally manufactured in white but has subsequently been made available in vivid colors to increase its visibility. The suture ears do not irritate the tissues because their shape memory is almost nonexistent. They have a high coefficient of friction due to their multifilament structure and thus may cause tissue damage when passing through the surrounding tissues.

Non-absorbable synthetic suture threads

Polyamide

Polyamide fiber, usually referred to as nylon, was the first synthetic fiber ever manufactured. There are two types available on the market, namely monofilament and multifilament. The monofilament type is the most commonly used non-absorbable nylon surgical suture thread due to its widely recognized high tensile strength and excellent elasticity. It also causes minimum tissue reactivity. The main disadvantage of this type of thread is its high memory, which requires a knot with an additional three or four loops to avoid the suture untangling. Some versions are soaked in an alcohol solution prior to packaging to reduce their memory and facilitate handling. Regarding multifilament types, there is a risk of them hosting more microorganisms due to their retentive surface structure, although they also feature good pliability for easy handling. Another disadvantage is that their capillarity is higher than monofilament types, and for this reason they are often coated in silicone.

Polypropylene

This is a monofilament suture thread that is difficult to handle, with a shape memory that is even higher than that of polyamide. In addition, the knot-holding security of this type of thread is very low, and the first knot often tends to loosen. Although it is possible to tighten the first knot with a second one in the same direction, it should be borne in mind that the benefit of this measure is very limited (see Fig 2-3). This thread is capable of maintaining its durability for years in a biologic environment without being degraded by tissue enzymes. It features a very slippery surface that does not adhere to tissues. It is a user-friendly thread with good tissue passage and does not invoke tissue reaction thanks to its chemical structure. As there is a very high possibility for suture ears to injure surrounding tissues if they are cut short, they should be cut long enough so that they rest freely on the tissues.

Polyester

This is a braided, multifilament, synthetic, non-absorbable suture thread. It has a high tensile strength and it is easy to handle. It has a low knot-holding security and tissue reactivity. Coated versions are available for improved tissue passage. The soft, pliable nature of polyester suture thread makes it suitable for suturing mucosal tissue or for use in intertriginous areas.

Polybutester

This non-absorbable, monofilament, synthetic suture thread is relatively new on the market. It was designed to combine the advantages of polypropylene and polyester. It also offers better handling than polypropylene, including lower memory, increased flexibility, and better knot security. Due to its unique elasticity, it responds well to edematous tissue and has very good tissue passage. Polybutester appears to be stronger than other monofilaments and does not have significant memory. Unlike nylon and polypropylene, polybutester does not maintain its packaging shape.

Polytetrafluoroethylene (PTFE)

PTFEs are synthetic, monofilament, non-absorbable sutures that are soft, biocompatible, and chemically inactive. PTFE is obviously more practical for intraoral applications than other monofilament sutures. Its prominent characteristics include durability, excellent tissue passage, high biocompatibility, low bacterial retention, and low memory (despite its monofilament structure). However, as it has low knot-holding security, it is advisable to make additional knots to lock it on both sides, since the possibility of knots loosening is very high if they are fastened under tension. Due to its porous structure, bacterial attachment would increase in cases where the sutures need to remain in the mouth for a long period of time.

Polyvinylidene fluoride

Polyvinylidene fluoride is a synthetic, non-absorbable, monofilament thread material. In recent years, polypropylene sutures have been associated in some clinical reports with suture failure. Polyvinylidene fluoride threads, in comparison, feature a smaller suture diameter, a greater knot pull strength, and less delayed extension when under creep testing. They are also more resistant to needle holder trauma than polypropylene threads.

Antibiotic-coated sutures are also available on the market although their use is controversial. Absorbable and non-absorbable suture materials have their advantages and disadvantages. When choosing suture materials, surgeons need to consider all these characteristic features and make a decision according to the needs of each individual case, based on their experience and knowledge.

SUTURE NEEDLES

Surgical suture needles are designed to carry suture threads through tissues with minimal damage to the tissues. They are therefore manufactured from high-grade stainless steel in various thicknesses compatible with the available suture threads. Surgical suture needles need to be durable and offer excellent physical strength and flexibility so that they do not break. The eye of the needle should not damage the tissues and, most importantly, the point should pierce the tissues flawlessly.

Needle anatomy

The area where the surgical suture needle is attached to the thread is called the swage end or the eye, the curved section between the eye and the point is called the body, and the section piercing the tissues is called the point in all surgical suture needles, regardless of their purpose of use (Fig 2-6).

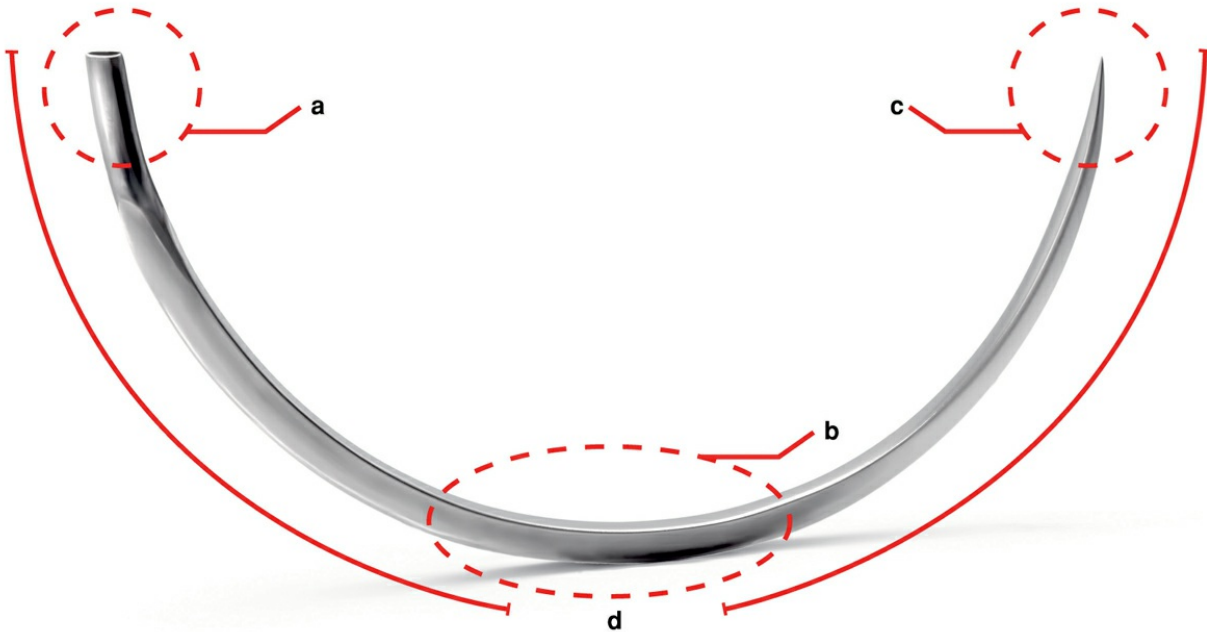


Fig 2-6 A suture needle comprises three main components: the eye [a], body [b], and point [c]. Needle length [d] is the distance between the eye and point.

Eye

This is the part of the needle formed into a loop for pulling the thread.

and swage end, with the last being the most commonly used today (Fig 2-7a and b). The eye is the weakest point of the needle and should never be grasped with a needle holder.



a

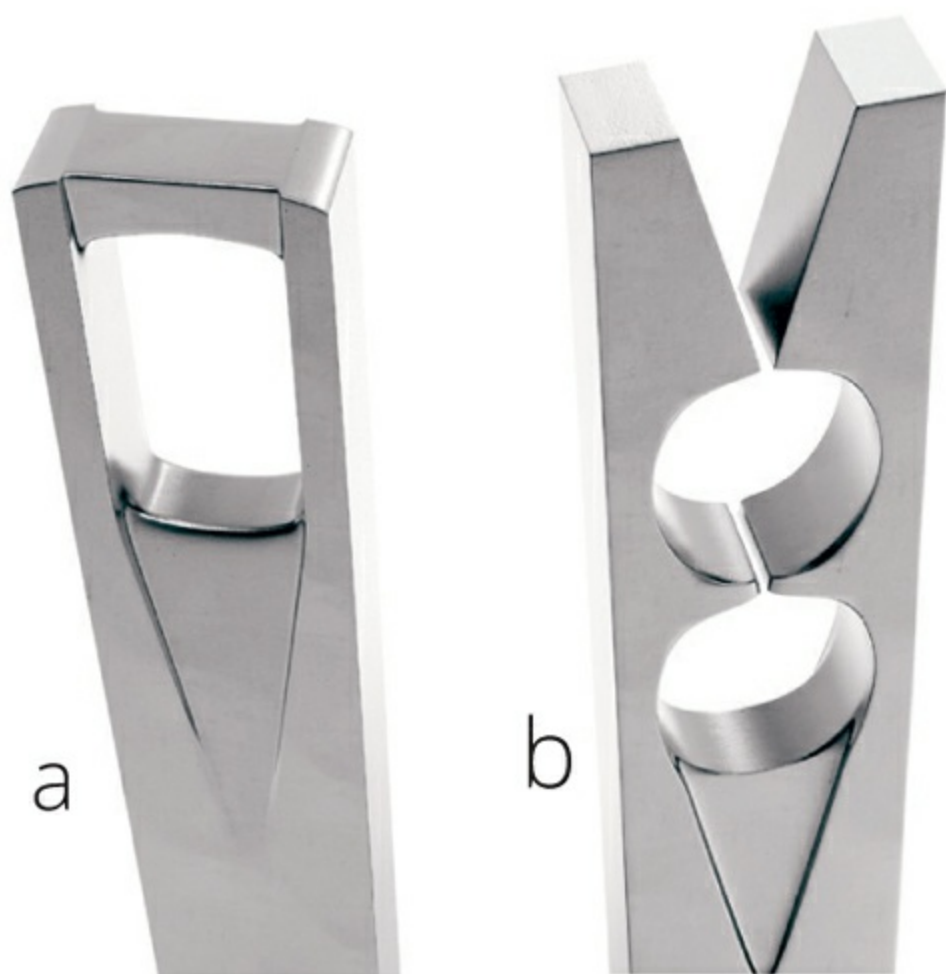




b

Fig 2-7 (a and b) Examples of swage end needles, currently the most common type used in dentistry. The eye is the part of the needle formed into a loop for pulling the thread. The eye is the weakest point of the needle and should never be grasped with a needle holder.

Closed eye needles resemble domestic sewing needles. The shape of the eye may be round, oval or square. Threading closed or French eye needles is a meticulous and time-consuming task. French eye needles have a slit at their rear end to facilitate this task. Another problem with closed eye and French eye needles is that a larger hole is forced in the tissues when inserting a double suture thread through it, leading to more severe tissue trauma (Fig 2-8a to c). In addition, the thread may slip out of the eye, further prolonging the operation time. These needles become blunt after repeated usage, making it difficult to pass them through the tissues. Currently, almost all surgical needles are of the swage end type.



C



Fig 2-8 (a to c) Threading through a closed eye (a) or French eye (b) needle is a time-consuming task because the diameter of these needles is not compatible with the thread, since the thread thickness eventually doubles as it goes through the eye. Swage end needles (c) have become widely used because this problem is eliminated.

In swage end needles, the thread is inserted in the slot at the rear end of the needle. Tissue passage is less traumatic with this type of needle, since the diameter of the needle and the swage end is compatible with that of the thread. Closed eye or French needles, on the other hand, cause a wound surface larger than the diameter of the needle each time they pass through the tissues with the suture thread (Fig 2-9).



Fig 2-9 Since the diameter of the needle and that of the attached thread are not compatible, the surface of the wound caused on the tissues by each passage of this type of needle is larger than that caused by a swage end needle.

Body

The body is the section of the needle between the end and the point. The body is the part that is grasped by the needle holder during the operation. There are various shapes of needle bodies (e.g. triangular or round), each one serving a particular purpose. The needle body should be able to maintain its shape throughout the procedure and not deform when grasped by the needle holder.

conventional cutting, round, or spatula (any form with more than three corners). Cutting needles have a triangular cross-section and are the most common type used in dentistry. They are referred to as reverse cutting needles when the base of the triangle faces the interior of the curvature of the body (Fig 2-10). Although surgical suture needles are available with both straight and curved bodies, needles with curved

bodies are most commonly used in dentistry. The curvatures of needles with curved bodies are identified by the ratio of their arc to a full circle, i.e. the arc of a $1/2$ circle needle is exactly half of a full circle. This type of needle is mostly used when the distance between the insertion and exit points is expected to be short. On the other hand, $3/8$ circle needles are mostly preferred for interproximal sutures due to their relatively open curvatures. In addition to $1/2$ and $3/8$ circle needles that are most commonly used in dentistry, $1/8$ and $5/8$ circle needles are also available for use on the skin (Fig 2-11).



a



b



their bodies, namely cutting, round or spatula. A cutting needle, the cross-section of which is triangular, is referred to as a reverse cutting needle (a) when the apex of the triangle faces the exterior of the curvature of the body. The possibility of rupture of the tissues by the thread is lower in sutures placed using this type of needle. If the apex of the triangle faces the interior of the curvature of the body, the needle is referred to as a cutting needle (b). These types of needles may damage the tissues through which they pass during suturing. Needles with a round cross-section (c) are difficult to grasp with a suture holder and can twist inside the tissues.

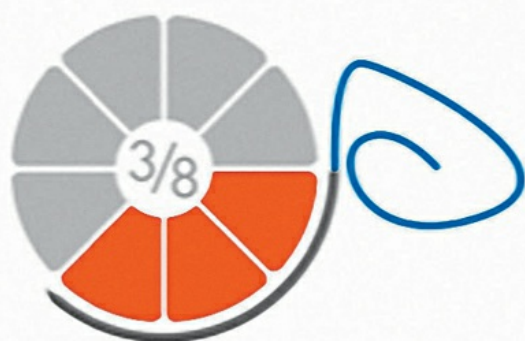
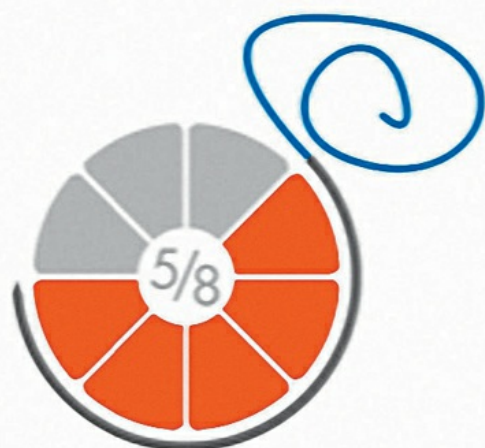


Fig 2-11 Needle curvatures are identified by the ratio of their arc to a full circle. Needles with a $1/2$ and $3/8$ circle are most commonly used in dentistry.

The entire needle structure comprising the eye, body, and point constitutes the needle length. The choice of needle length depends on the distance between the tissue layers through which the needle is going to pass, where in the oral cavity the needle will need to reach for the particular procedure, and the experience of the surgeon. Usually, needles with a length of 10 to 22 mm are used in dentistry (Fig 2-12).



Fig 2-12 The choice of needle length depends on the purpose of the surgery, tissue thickness, and access to the surgical site.

Point

Sharp needle points that can easily penetrate through tissues are most often used in dentistry. The cross-section of triangular needles becomes thinner toward the point (Fig 2-13a and b). Sharp-pointed needles pierce and penetrate through the tissues. Needles with round or tapered cross-sections become thinner and sharper toward the point. These types of needles are mostly used for nonfibrotic tissue to

avoid neurovascular damage (Fig 2-13c). Blunt needles, on the other hand, are used to advance between the layers without penetrating into the tissues, although their use is limited in dentistry.

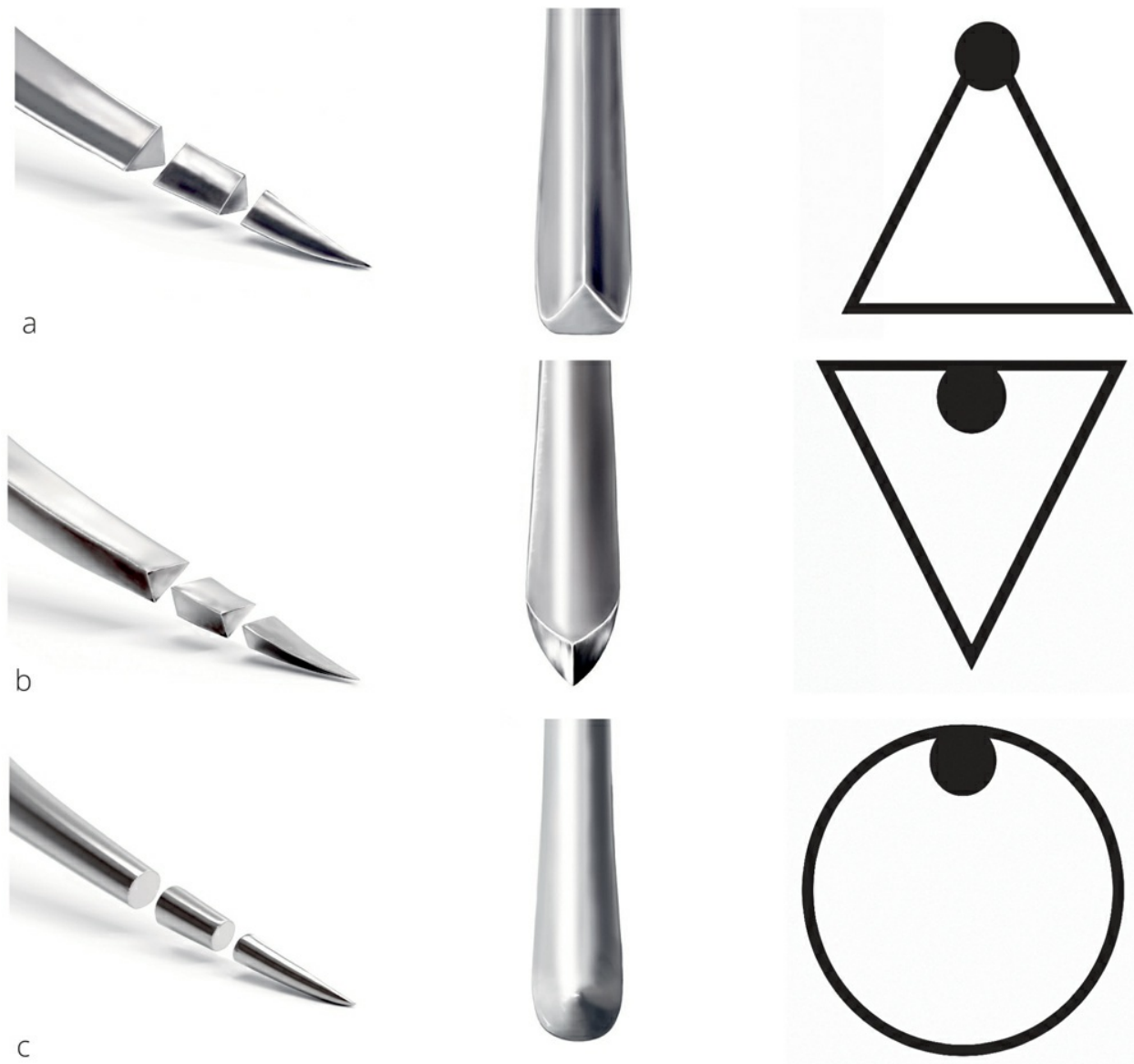


Fig 2-13 (a to c) Both needles have sharp points so that they cause minimal tissue damage. The passage created by a conventional cutting needle (a) is more prone to rupture by thread tension than that of a reverse cutting needle (b), which is more resistant to damage caused by threads. The cross-sections of round needles (c) also narrow down toward the point. Although the passage these needles

create through the tissues is not prone to rupture, they can easily twist inside the tissues, hindering the operation.

The choice of needles in dentistry is based on their curvature and cross-section. Sharp-pointed needles are suitable for all oral surgery operations. It is advisable to use a 3/8 circle needle for suturing interdentally and a 1/2 circle needle when fixing the opposing mucosal margins. All needles should preferably be of the reverse cutting type.

HAND INSTRUMENTS

Needle holders

Needle holders are used to grasp surgical suture needles in order to guide them through the tissues. Their main purpose is to immobilize the needle they grasp and to ensure that it does not slip. Currently, needle holders are commercially available with short, straight, concave, convex, serrated or non-serrated jaws. The teeth added to the non-serrated jaws for an increased grip often damage or break suture threads. Needle holders with serrated jaws are therefore more convenient for use (Fig 2-14a to c).



a



b



c

Fig 2-14 (a to c) It is advisable to use needle holders with non-serrated jaws when using thin suture threads to avoid damage to the thread structure (a). Serrated jaws may damage the structure of 3-0 or thicker threads, but would not cause them to break (b). Tungsten-

carbide coating of the jaws and joint prevents corrosion on the beak of the needle holder caused by prolonged usage (c).

Although many types of needle holders are currently available on how they are handled. There are a variety of needle holders with finger-ring handles (sometimes incorrectly referred to as hemostatic clamps) such as Mayo-Hegar, Crile-Wood, Webster, and Collier (Fig 2-15a to d). As with most other surgical hand instruments, needle holders are named after the surgeon who designed them. Since hemostatic clamps are specially designed to grasp the tip of blood vessels to stop bleeding, particularly at hemorrhagic sites, their grasping jaws are considerably different to those of needle holders (Fig 2-16). Needle holders are held with the thumb and the ring finger and are supported by the index finger (Fig 2-17).



a







C



Fig 2-15 (a to d) Needle holders with finger-ring handles are available in varieties such as Mayo-Hegar (a), CrileWood (b), Webster (c), and

Collier (d). Although their handles are all the same, their jaws differ depending on the suture thread and needle to be used.



Fig 2-16 The tooth structure of hemostatic clamps is more aggressive than that of needle holders. This allows hemostatic clamps to stop the bleeding completely through the pressure applied until the relevant blood vessel has been tied off. However, it should always be borne in mind that this surface specification may damage the suture threads.

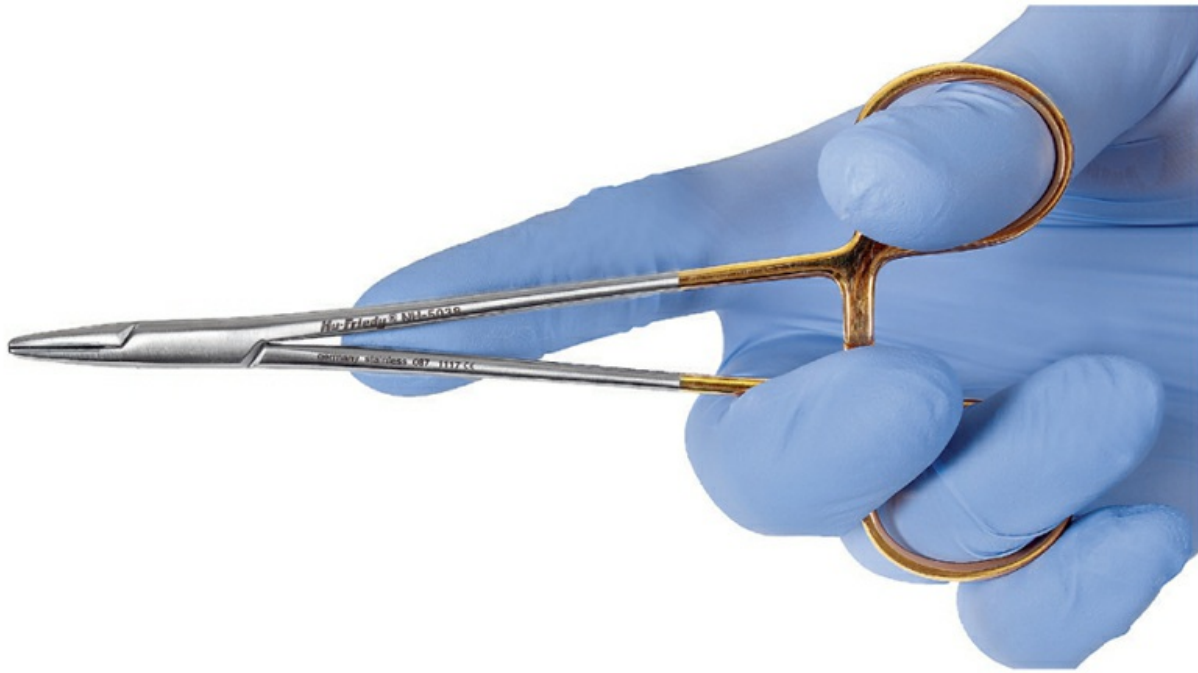


Fig 2-17 The needle holder is held in balance between the thumb and ring finger and guided with precision by the index finger. In this way, minimal pressure is applied on the needle to avoid the twisting of the needle due to the resistance it encounters when passing through the tissues.

Another type of needle holder, called the Mathieu, Arruga or Boynton, is designed to be held in a palm grip (Fig 2-18a to d). Castroviejo needle holders are held in a pen grip as opposed to a palm grip (Fig 2-19a and b). In principle, needle holders with finger-ring handles and those held in a palm grip are more convenient for thick suture needles and for relatively low-precision operations, whereas those held in a pen grip are more practical when working with 5-0 or thinner threads or when performing high-precision operations.





Fig 2-18 (a to d) Mathieu (a), Arruga (b), and Boynton (c) are the most commonly used palm grip needle holders, with Mathieu being the most popular among them. Mathieu needle holders require the exertion of force when used in high-precision operations, causing the hand to lose its balance (d).



a



Fig 2-19 (a and b) Castroviejo needle holders are more suitable for high-precision procedures when working with smaller/thinner needles as they can be held in a pen grip (a), allowing the surgeon to gain support from the stationary tissues (b).

The size of the needle holder to be used should be appropriate for the size and diameter of the needle. A very small surgical suture needle should be handled with a needle holder supporting a thin, small, and delicate working site. Larger surgical suture needles should be grasped using heavier needle holders supporting relatively less-delicate sites. The size of the hand tool to be used should be compatible with the position of the surgical site.

How to use needle holders

1. The needle should be held 1/3 or 1/2 of the way down the body shaft from the end. The needle should not be held on or around the swaged end (the point where the thread is attached to the needle), since this is the weakest point of a surgical suture needle (Fig 2-20).



Fig 2-20 Ideally, the needle should be grasped by the needle holder exactly in the middle. If it is necessary during the procedure to go back, the surgeon should travel up the body shaft of the needle only a third of the way. If one goes beyond this point, however, there is the risk of squeezing the swage end and dislodging the thread. Therefore, the needle should never be held on or around the swage end, nor should it be held at the front end near the point because this commonly causes bending, breakage or blunting of the needle tip.

2. Excessive pressure applied by the jaws of the needle holder may cause permanent deformation of the needle. When using a locking needle holder, it is sufficient only to lock it. If the needle is not grasped well after the hand tool is locked, it means that the needle holder is either worn out or is not suitable for the needle size being grasped.

Ensure prior to use that the jaw of the needle holder operates freely and locks properly. Always use a needle holder to remove a needle from tissue. Using a hemostatic clamp or any other forceps will damage the needle.

Scissors

Scissors are mostly used for trimming tissues, dissecting tissue layers, and removing sutures. Any type of scissors can be used to remove sutures (Fig 2-21a to e).



a





b



c



d



e

Fig 2-21 (a to e) The jaws of scissors designed for suture removal join their body at an angle (Dean scissors) (a). This angle facilitates the removal of knots from the mesial or distal area of the teeth. The tips may be blunt to prevent tissue damage or custom-designed to separate an impacted thread from the surrounding tissues when healing (b). Curved tissue scissors prevent damage to neighboring tissues during suture removal (c). However, scissors designed for trimming tissues and dissecting layers are extremely sharp and pointed (d). Scissors suitable for removing smaller-diameter suture threads are also available (e).

Scissors are usually held between the thumb and ring finger. The index finger should rest on the joint of the scissors (Fig 2-22).



Fig 2-22 It is possible to prevent tremor while using scissors to cut the suture thread at the desired point by using the index finger to lightly support the joint of the instrument.

Tissue forceps

Tissue forceps are mostly used in surgical procedures for grasping tissues. They may also be used to retract and stabilize tissues for observation purposes or to secure tissues during suturing. Surgical tissue forceps are available with or without teeth in a variety of shapes and sizes for use in a wide range of surgical sites. Although tissue forceps without teeth cause less damage to the tissues they grasp, the tissues may easily slip due to their insufficient grasp. These hand instruments are available with a variety of tips at different angles, depending on the purpose and area of use (Fig 2-23).



Fig 2-23 (a and b) Tissue forceps are used to support the tissues when passing a suture through them. They are available in straight (a) and curved (b) types. The tips of these forceps are serrated to grasp the tissues easily without allowing them to slip.

The advantage of tissue forceps with teeth is that they can grasp the tissues firmly with less pressure being exerted. However, the teeth of these forceps may damage the tissues being grasped if too much pressure is exerted (Fig 2-24).



Fig 2-24 Tissue forceps with teeth incorporate a variety of grip configurations to easily grasp the tissues. Although they are capable of doing this without allowing the tissues to slip, they may cause damage to tissues with a thin phenotype.

High-precision tissue forceps are also available. These forceps are specially designed to engage a suture needle through the tissues exactly at the targeted point (Fig 2-25a and b).



Fig 2-25 (a and b) Using tissue forceps with a guiding hole at the very end would facilitate placing sutures exactly at the desired position (a). Inserting the needle through the holes on both shafts of these forceps,

which are aligned to each other, would facilitate suturing, particularly when handling soft tissue (b).

TISSUE ADHESIVES

With mechanical measures such as sutures and staples readily available on the market, tissue adhesives have been very much overlooked in the past. However, with technological advancement and improvements in adhesive materials, this situation has changed rapidly in recent years. The use of adhesives in wound closure has increased due to their ability to shorten wound closure time in cosmetic and reconstructive procedures, to widen the point of pull and thus reduce tension at the wound margins, to displace and stabilize large flaps, to cover tissues that are left exposed, and to stabilize wounds.

Tissue adhesives should:

- be biocompatible and biodegradable, without adversely affecting wound healing;
- have high tissue adhesion and cohesion;
- be quickly and easily prepared with convenient curing time;
- be hydrophilic, allowing operation on wet surfaces at body temperature;
- have an elasticity similar to that of the tissues to be adhered;
- not release heat during curing; and
- cause minimal inflammatory response during dissolution.

Currently, no single adhesive meets all these requirements.

Fibrin adhesives

An adhesive made from a combination of thrombin and fibrinogen was first used in the early 1940s. Fibrin adhesives are primarily used for hemostasis of large areas in head and neck surgeries. Although they

are very effective in hemostasis, they are relatively weak adhesives. It takes a long time to prepare fibrin tissue adhesives due to the high number of ingredients they contain. They are fully biocompatible and resolvable materials.

Collagen and protein-based adhesives

These materials are developed as two-phase adhesives, taking advantage of the cross-linkage property of connective tissue constituents. An air- and liquid-tight, protein-based adhesive is formed when collagen is cross-linked to glutaraldehyde. It also forms a bond, albeit weak, with the tissues, and is thus considered to be an adhesive as well as a membrane. Nonetheless, these tissue membranes have many disadvantages, as follows:

- They may cause interspecies transmission of diseases as they are obtained from bovine serum albumins.
- They can possibly lead to hypersensitivity since they contain foreign proteins.
- Glutaraldehyde, which is used as a cross-linking agent, is a neurotoxin.
- They take a long time to be absorbed/dissolved and cause a high inflammatory response.

Cyanoacrylates

These adhesives have been used for general wound closure for many years and are increasingly being used today in the oral cavity. All cyanoacrylates operate according to the same principle, i.e. they are initially applied as monomers and quickly transform into polymers with a high molecular weight.

Although cyanoacrylates are strong, antimicrobial adhesives, they are associated with severe inflammatory response because they are hydrophobic. In addition, they cannot be biologically absorbed. Their use is limited to superficial coverage of tissues. Nonetheless, they

ensure strong adhesion at the wound margin, allowing the subcutaneous tissue to heal normally. Cyanoacrylates are used to save time and to obtain flexible and waterproof wound closure. Although they are mostly used in smaller wounds, they can also effectively close larger wounds where subcutaneous sutures are required. A minor exothermic reaction occurs during hardening, although this heat is not often noticed by the patient.

Polyurethane adhesives

These adhesives incorporate many positive features, making them the preferred adhesives for biomedical use. They react with the hydroxyl and amine content of the tissues, which results in a strong superficial synthesis. They also cure quickly in aquatic environments. Recent clinical studies on tissue adhesives derived from lysine have suggested that these products may be useful in deep tissue coverage. They are biocompatible, absorbable, nontoxic materials. They increase surgical success by closing the wound very effectively in the operation site. Polyurethane adhesives yield the best result when used on smooth areas. They are highly successful in large traumatic wounds and large soft tissue flaps and are also good at reducing dead space and preventing hematoma and seroma (buildup of fluid between the tissue layers).

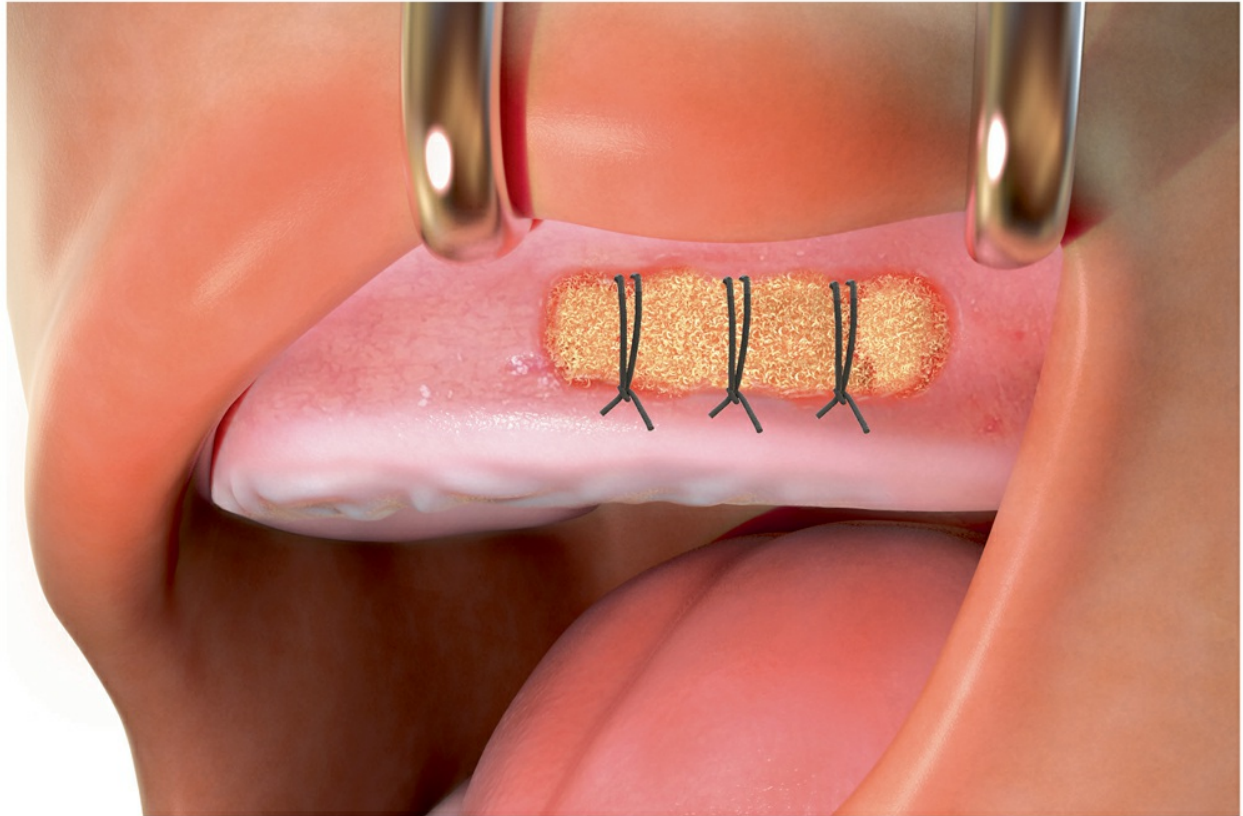
Recommended reading

1. Dart AJ, Dart CM. Suture Material: Conventional and Stimuli Responsive. *Comprehensive Biomaterials II*, Volume 7. Elsevier, 2017:746–771.
2. Asher R, Chacartchi T, Tandlich M, Shapira L, Polak D. Microbial accumulation on different suture materials following oral surgery: a randomized controlled study. *Clin Oral Investig* 2019;23:559–565.
3. Buckley MJ, Beckman EJ. Adhesive use in oral and maxillofacial surgery. *Oral Maxillofac Surg Clin North Am* 2010;22:195–199.

4. Burkhardt R, Lang NP. Influence of suturing on wound healing. *Periodontol 2000* 2015;68:270–281.
5. Nelson WJ. Guide to suturing. *J Oral Maxillofac Surg* 2015;73(8 suppl):1–62.
6. Silver E, Wu R, Grady J, Song L. Knot security – How is it affected by suture technique, material, size, and number of throws? *J Oral Maxillofac Surg* 2016; 74:1304–1312.

CHAPTER 3

SUTURING TECHNIQUES



GENERAL PRINCIPLES OF SUTURING

The wound closure process has an important effect on the outcome of the surgery. Simple mistakes made while suturing can damage the tissues and cause the sutures to rip, making them dysfunctional and exposing the wound. This leads to failure of the surgical procedure.

While a broad outline of the general principles of suturing are discussed in this chapter, it should be borne in mind that every surgical intervention is performed under unique circumstances specific to that procedure. Therefore, modifications could and should be made to facilitate the best possible wound closure based on wound healing principles. Consequently, the type of suturing to be used should be reevaluated for each surgery based on the requirements of that particular intervention.

It is advisable to consider the recommendations in the following section during the surgical planning process.

Suture characteristics

- Choosing a suture thread that is weaker than the tissues to be sutured is more likely to result in the thread breaking than the tissues being ruptured. The diameter of suture thread should therefore match the gingival phenotype and/or the type of surgery.
- Suture ears should not be allowed to damage the surrounding tissues. To prevent this, cut the ears long. The ears of monofilament threads with a high shape memory should be cut longer than those of multifilament threads.
- It is very important to consider the goal of the procedure to be performed when selecting the type of suture and thread, e.g. only multifilament threads should be selected for sutures used to stop a wound from bleeding. Another consideration is that these sutures will not be permanent. Obviously, a suture thread with high knot-holding security should be selected for these sutures because the main goal

is to stop the bleeding by strangling the surrounding tissues over the blood vessel. Similarly, multifilament suture thread should be used for retraction sutures, where it is expected that the first knot will start holding the tissues in the desired position.

- To improve healing, it is very important to keep the site free of microorganisms after closure. Therefore, it is advisable to use monofilament suture threads with low capillarity that would not induce communication between the interior of the wound and the oral cavity when using biomaterials under the flap (i.e. for membranes, grafts or implants).
- After needle length, needle curvature is another feature that determines the distance point where the needle bites and leaves the tissues. A 3/8 circle needle is more appropriate for interdental sutures, while a 1/2 circle needle is better to secure two neighboring mucosal margins together.
- Using a conventional or reverse cutting needle would avoid the needle turning around or rolling when it is administered into the tissues.
- Using a reverse cutting needle would minimize the risk of tissue rupture in fragile and thin tissue.

Suturing techniques

- Sutures should preferably be initiated from the mobile (movable/non-keratinized) tissue and proceed to the immobile (fixed/keratinized) tissue, although exceptions exist.
- The force exerted to insert the needle through the tissues should be in the same direction as the curvature of the needle.
- Sutures used to approximate flaps or to relocate or displace tissues as well as those used to fix wound margins should not be combined in a single suture but should be placed separately. As the approximation (displacement or sliding) suture will exert more tension on the tissues, this will result in impairment of circulation at the points where the tissues are engaged. Since the direction of tension faces

the same aspect as the healing wound margin, impairment would result in unfavorable blood supply to the wound site. Blood circulation is crucial for the wound margin to heal well, as discussed in Chapter 1.

- The needle should bite and exit the tissues at a safe distance from the edge of the wound and should not cause tissue rupture. Sutures that are too close to wound edges may cause tissue damage due to the tension created by postoperative edema.
- If the tissues begin to whiten when the knot is fastened it indicates that the loop has been overtightened. This endangers circulation and requires the revision of the knot.
- Although engaging both sides of the wound with one bite of the needle may appear to speed up the procedure, it is not essential to do this. Therefore, if the first attempt to engage both sides in one bite fails it is advisable to catch the sides separately.
- Excessive force should not be applied, nor should the needle be twisted out of its curvature when exiting from the tissues. It is advisable to provide opposing support from the other side. The needle can bend at the point where the force is exerted, especially if only the tip is gripped with a needle holder in cases where it merely sticks out of the tissues.
- Sutures should be positioned on keratinized tissue when possible because of its superior physical properties compared with non-keratinized tissue. This prevents wound edges from folding or overlapping.
- The knot should be located at the immobile side, if possible (i.e. the side where a flap is not elevated). To avoid plaque accumulation, the knot should not be placed on the incision line.
- Sutures should be performed starting from the anterior and proceeding toward the posterior to ensure that surgical forceps and suture holders used while placing the sutures do not block the view of the incision site. This working procedure also ensures that the view is not blocked by the bleeding when the patient is in a supine position.

Operational safety

- Patients should preferably wear protective eye goggles. If this is not possible, however, they should be asked to close their eyes at the time of suturing. This is even more crucial in modern dentistry, since most procedures are performed under magnification, with the surgeon's complete focus on the magnified working site.
- Suture needles can bend if they are forcibly inserted through fibrotic or osseous tissue. In such cases, straightening the needle would lead to metal fatigue and needle breakage. In case of broken needles, the fragments must be counted to ensure that nothing is left in the tissue layers.
- Used surgical suture needles must immediately be deposited in the sharps waste bin.

Function-based classification of suturing techniques

Although surgical procedures require advance planning and are subject to a set of rules, every single surgery is performed under different and specific circumstances. Consequently, making modifications as required is not unusual and is, in fact, often necessary in order to facilitate the correct circumstances for optimal wound healing. Thus, an understanding of the philosophy of suturing is required, based on the conditions under which sutures are used, and on the advantages and disadvantages of different types of sutures.

function, as follows:

- Wound closure sutures.
- Displacement sutures for approximating wound margins.
- Sling sutures.
- View-enhancing (tissue retraction) sutures.
- Fixation sutures for biomaterials or grafts.

- Sutures for securing surgical dressings or packings.
- Hemostatic sutures.
- Positioning sutures.
- Sutures to prevent foreign material from traveling into deep tissue.
- Abscess drainage sutures.

WOUND CLOSURE SUTURES

This type of suture is used to close or seal wound margins without leaving a gap, ensuring perfect adaptation of wound margins. They may be single or continuous sutures. Impaired circulation threatens the healing margin of the wound, exerting an adverse effect on tissue nourishment. Therefore, the threads of wound closure sutures should not exert pressure on the tissues, since any tension at the point of bite would impair circulation. Consequently, care should be taken to ensure that wound closure sutures are different from those used for approximating wound edges. However, wound closure sutures should not be located in between the healing margins (i.e. the line of cut) because sutures located in the intermarginal space will act as a course for the communication of fluid and microorganisms within the oral cavity (Fig 3-1).

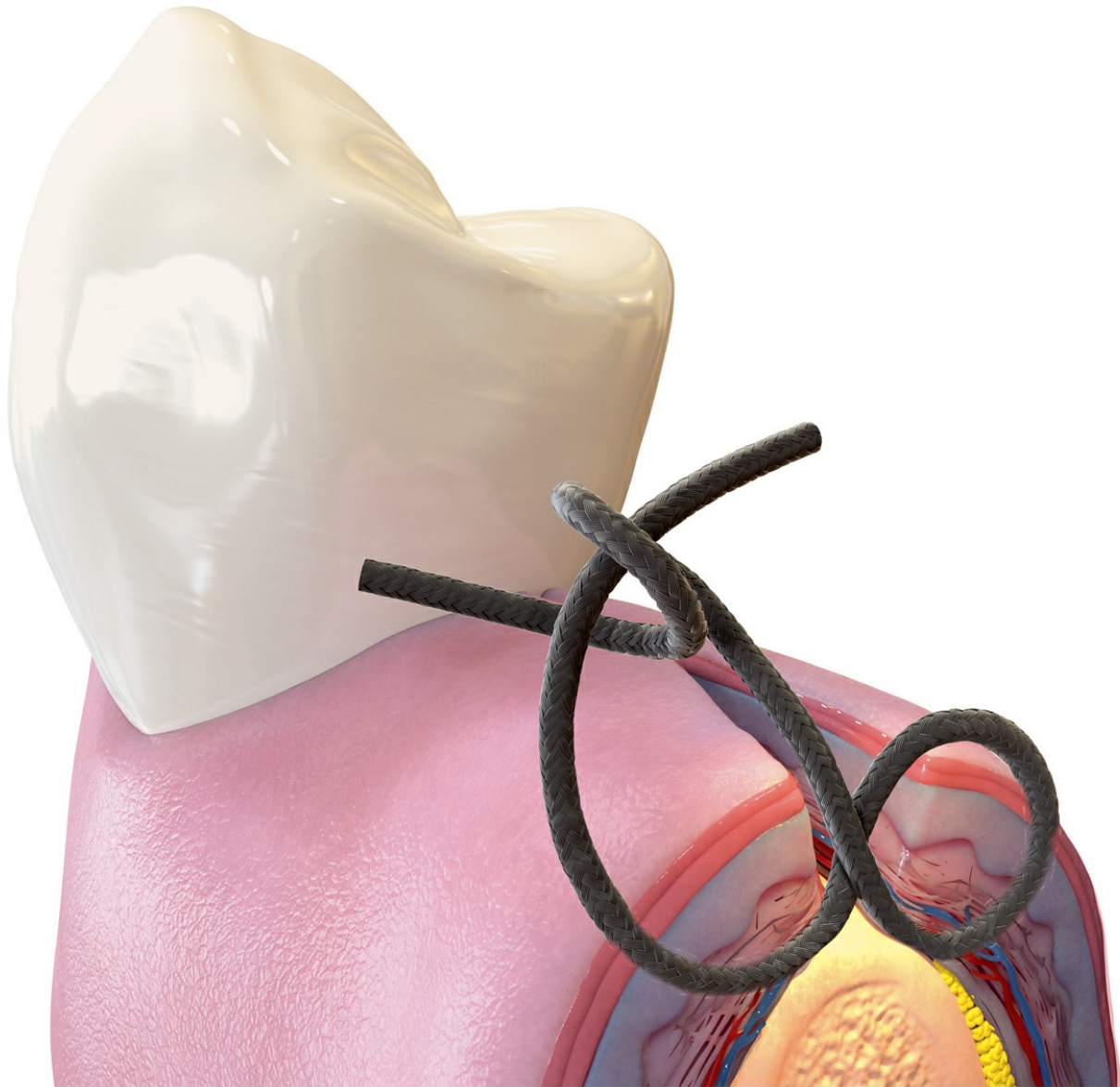


Fig 3-1 Suture threads that remain in between the wound margins impair healing because they function as a retentive area for microorganisms. In addition, they allow communication between the interior and exterior of the wound due to their braided texture that facilitates capillarity.

Interrupted sutures

Areas of usage

This type of suture is used to secure already approximated tissue. The tension on the suture may hamper circulation on or around the wound edges when these sutures are used to approximate tissue.

Advantages

They are simple to perform and do not require the surgeon to be experienced.

Disadvantages

In cases where multiple interrupted sutures are placed alongside each other, it can be difficult to align the tissues because the sutures function individually. In addition, the duration of the surgery would be longer than planned due to the requirement to lock each single suture individually. It is recommended to use continuous sutures in such cases.

Technique

Mobile tissue is first stabilized with a tissue forceps pursuant to the general principles of suturing. A surgical needle is then inserted through the tissues from the outer surface of the flap at an angle of 45 to 90 degrees, 2 to 3 mm away from the edge of the wound in order to avoid rupturing the tissues. The needle is then engaged into the other side of the wound through the inner surface of the flap, exiting on the outer surface. A knot is tied and pulled to the immobile side, ensuring that it does not rest on the incision line. When cutting off the excess thread, care should be taken to leave a 3- to 4-mm-long ear for multifilament threads and a 7- to 8-mm-long ear for monofilament threads (Fig 3-2). The space between the sutures will depend on the thickness of the suture thread used and the fibrotic nature of the tissue itself. However, in general, the distance between two interrupted sutures should be around 4 to 5 mm to allow for nourishment of the tissues. It is possible to place sutures closer to each other as their diameters become smaller.

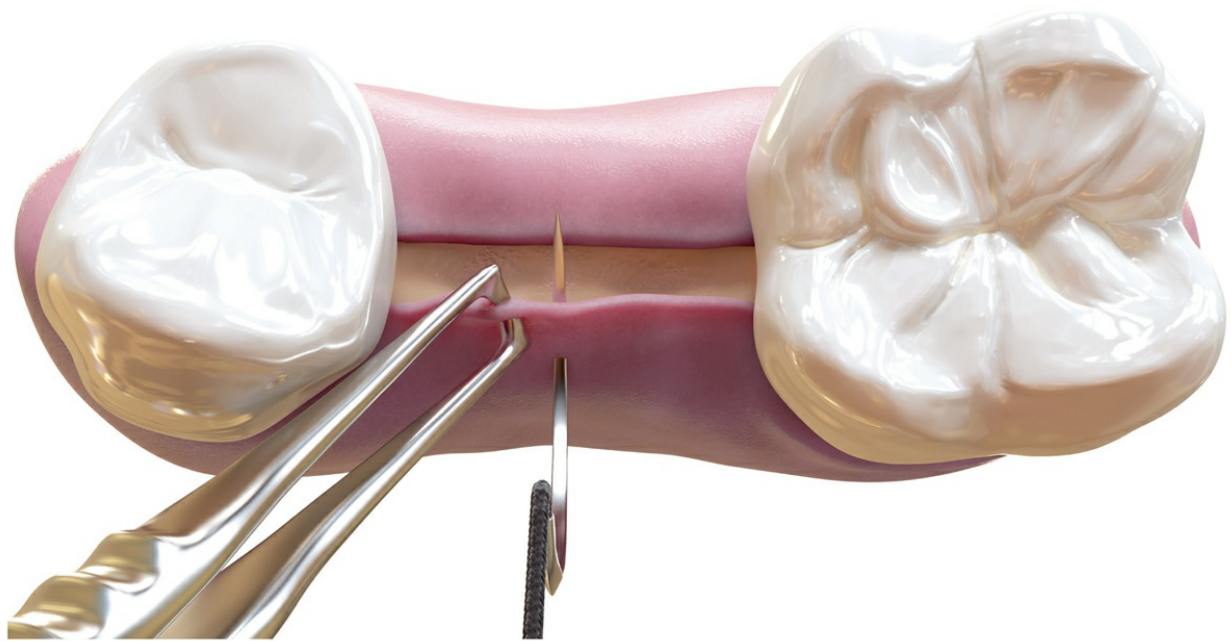


Fig 3-2 (a) Mobile tissue is stabilized with a tissue forceps. The needle is then inserted through the tissues at an angle of around 90 degrees to minimize tissue texture resistance.

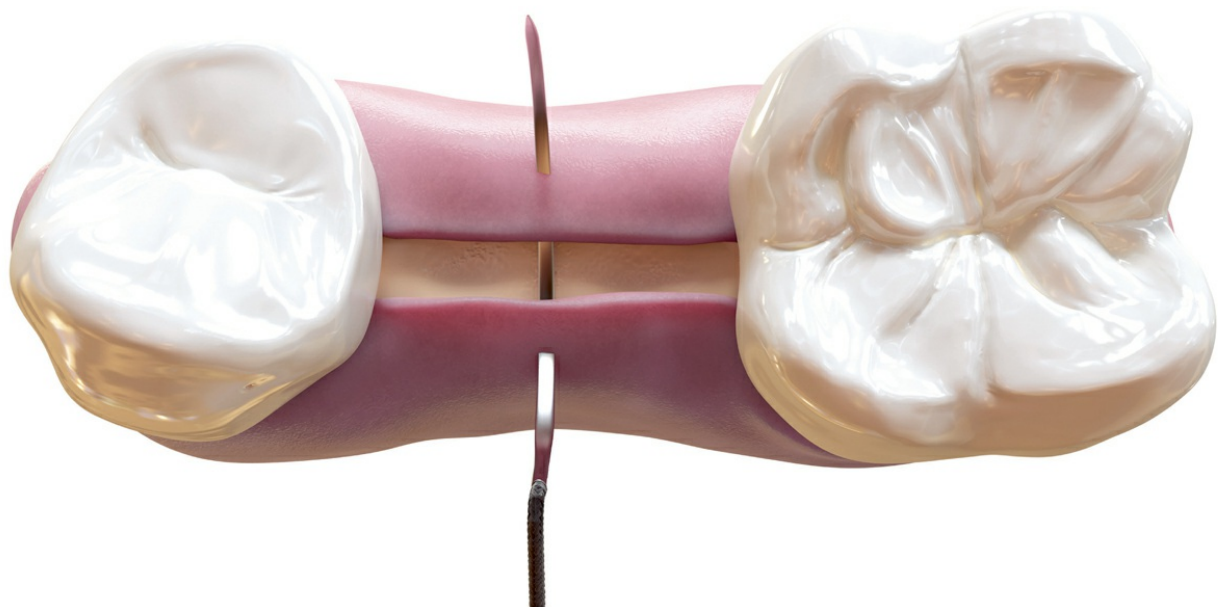


Fig 3-2 (b) It is recommended to bite the tissues with the needle one by one on both sides of the wound. Although it is possible to catch

both sides at once, this will lead to inaccurate positioning of the bite with respect to the incision line.



Fig 3-2 (c) Without applying excessive force, the needle is advanced with a needle holder at an equal distance from both sides of the wound, i.e. the bite points should preferably be at an equal distance from the incision line on both sides. The force should not be applied linearly but along the course of the curvature of the needle.

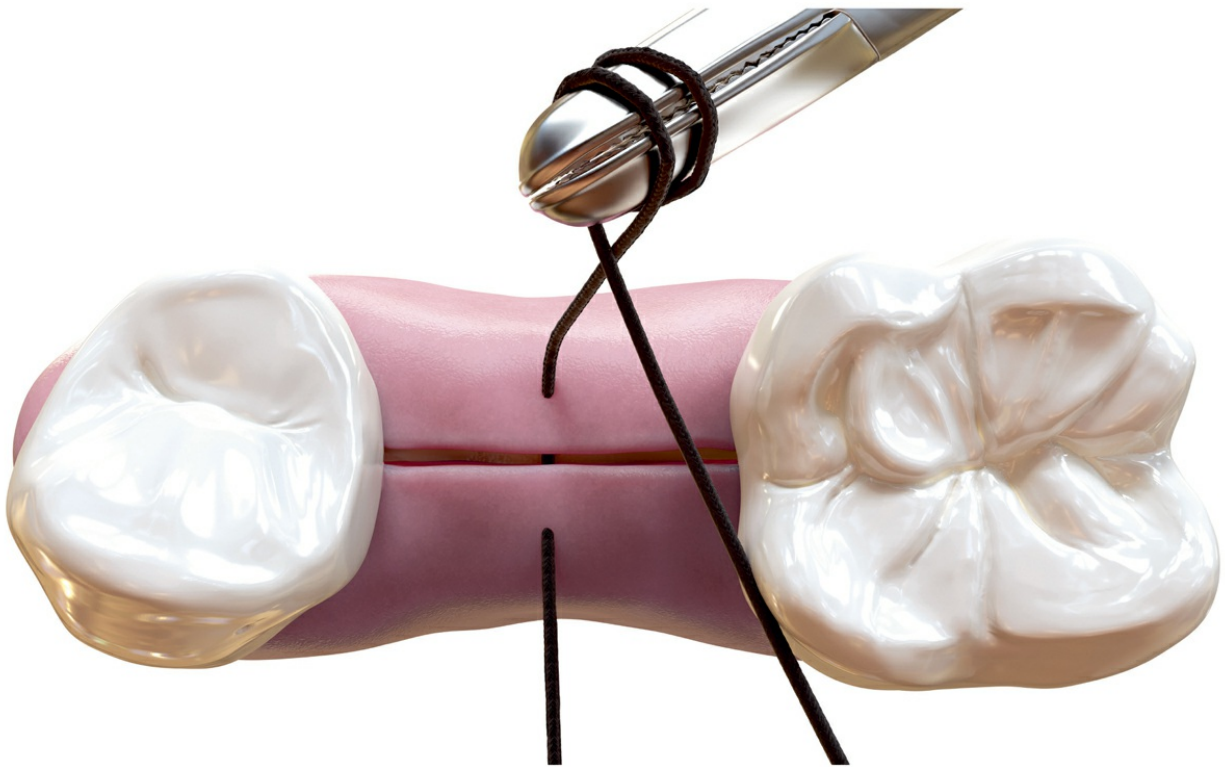


Fig 3-2 (d) The long end of the suture thread is gathered up on the immobile side, and the short free end of the thread is placed on the other side. Then, the thread is wrapped twice clockwise around the tip of the suture holder, which remains on the top.



Fig 3-2 (e) The short end of the suture thread is secured with the needle holder and a knot is tied. The second loop must be made in the other direction to lock the suture.

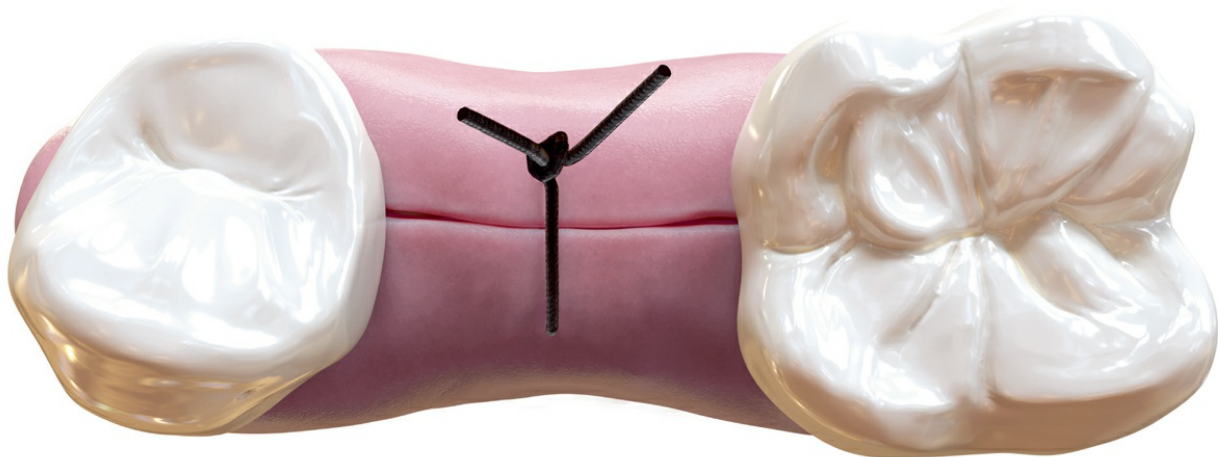


Fig 3-2 (f) The suture ears are cut off to leave 4- to 5-mm-long ends for braided sutures. Monofilament sutures should be cut with longer ears to overcome the plastic memory of the material. Interrupted

sutures should be used to secure wound edges that are already approximated to each other in a tension-free way.

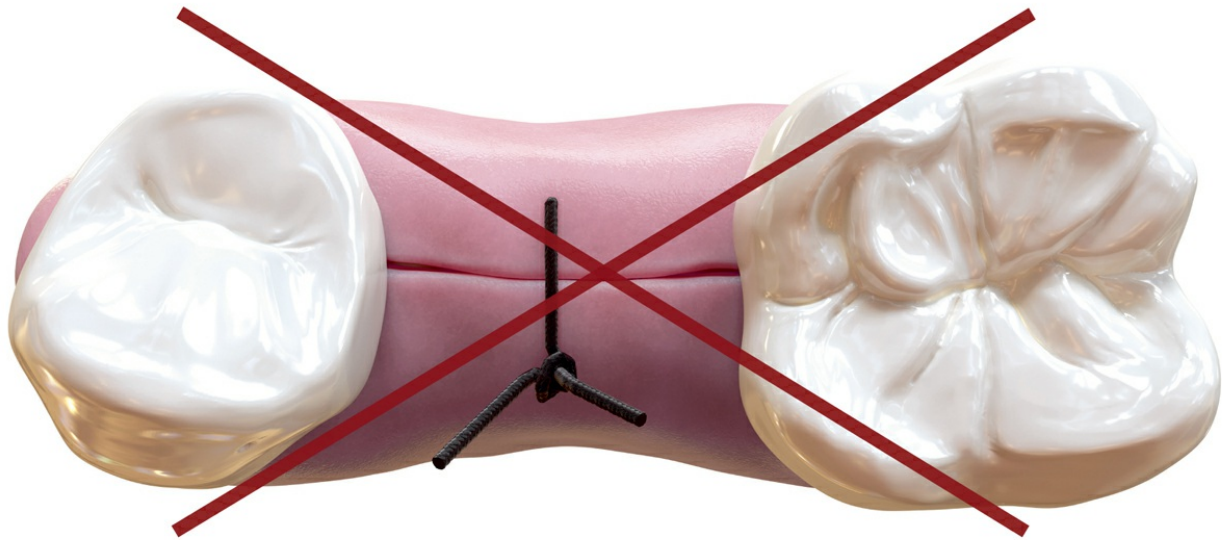


Fig 3-2 (g) For unilaterally elevated flaps, the knot should be positioned, whenever possible, at the unelevated rather than the elevated side.



Fig 3-2 (h) This cross-section illustration clearly indicates that the knot should not be placed on the incision line. The thread should also not transverse between the wound edges. Note that the bites are positioned at an equal distance on both sides of the incision.

It should be borne in mind that interrupted sutures should not be used to approximate wound edges, but rather to secure wound edges that have already been approximated by mattress sutures. The type of interrupted suture passing through wound edges (see Fig 3-1), occasionally referred to as a figure-of-eight suture, is not recommended because it adversely affects wound healing; however, it can be used to fix two mobile flaps that tend to overlap one another.

Suture threads passing in between the wound margins would firstly cause an unwanted exchange between the interior and exterior of the wound, and secondly cause a foreign object to be placed between the two edges of the wound, which would prevent the convergence of the two sides of the wound.

Simple and locking continuous sutures

Continuous sutures are those that bite the wound edges more than once without any knots being tied.

Areas of usage

This type of suture is mostly used on long edentulous areas where only one of two opposing flaps is mobilized.

Advantages

Continuous sutures can save time because the process of tying knots and cutting thread ends is eliminated. The main advantage of this type of suture is the balanced distribution of tension on the tissues, since the bite to the tissues occurs at multiple opposing positions.

Disadvantages

Bilaterally elevated flaps (i.e. flaps on both sides) demonstrate a high tendency to fold, especially in non-keratinized tissue. If the thread breaks at any point during suturing, the procedure is made more complicated. In such cases, it is recommended to untie the loop, tighten the knot, and restart a new suture. However, later suture failure during wound healing may result in the divergence of the wound edges, leading to a larger open wound.

Technique

Simple continuous sutures

These sutures should be considered as repetitive interrupted sutures, without knots being tied. Apart from the first one, the ears of

interrupted sutures placed at equal intervals are not cut off. Knots are usually tied at the first and last loops (Fig 3-3).



Fig 3-3 (a) Continuous sutures should be initiated with a single interrupted suture. After a knot has been tied and locked on the first single suture, the ear should be cut off.



Fig 3-3 (b) Single sutures are placed continually with the needle end of the thread until the wound is closed, starting from mobile and moving to immobile tissue. Care should be exercised to maintain an equal distance between the individual sutures.

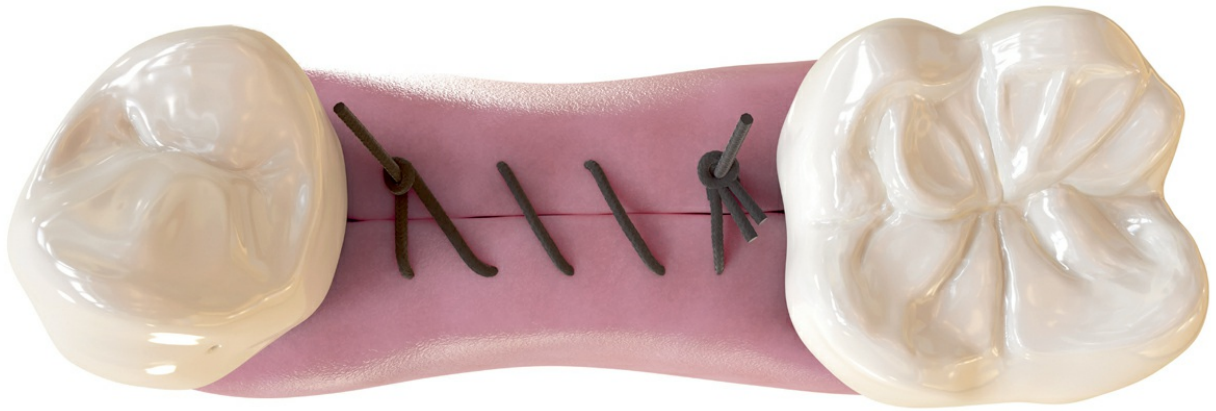


Fig 3-3 (c) The final loop is tied with the needle end of the thread. This knot should rest on the immobile side, leaving three ears.

Since simple continuous sutures cause slight displacement of tissue margins at an angle, they are not very often used. However, they are convenient for partial tissue displacement. The locking version of this suture (see below) is ideal when angular displacement of the tissues is to be avoided.

Continuous locking sutures

The initial step comprises a single interrupted suture. After placing this suture and cutting only the short ear of the knot, a second interrupted suture is initiated 4 to 5 mm away from the first one, in a similar manner to simple continuous sutures. At this stage, prior to placing the next suture, the thread is taken through the loop made between the first and second suture, thus forming a lock. This procedure is repeated until the wound edges are completely closed. The last suture is formed without passing through the last loop, but by simply fixing a knot with the loop at the needle end of the thread. The knot should preferably rest on the immobile side (Fig 3-4).



Fig 3-4 (a) A single interrupted suture is placed. The knot is positioned at the immobile side and the ear is cut off after tying the knot.



Fig 3-4 (b) The following suture is initiated from the elevated side of the wound toward the immobile side. The loop between the two sutures is left wide and loose for the next step.

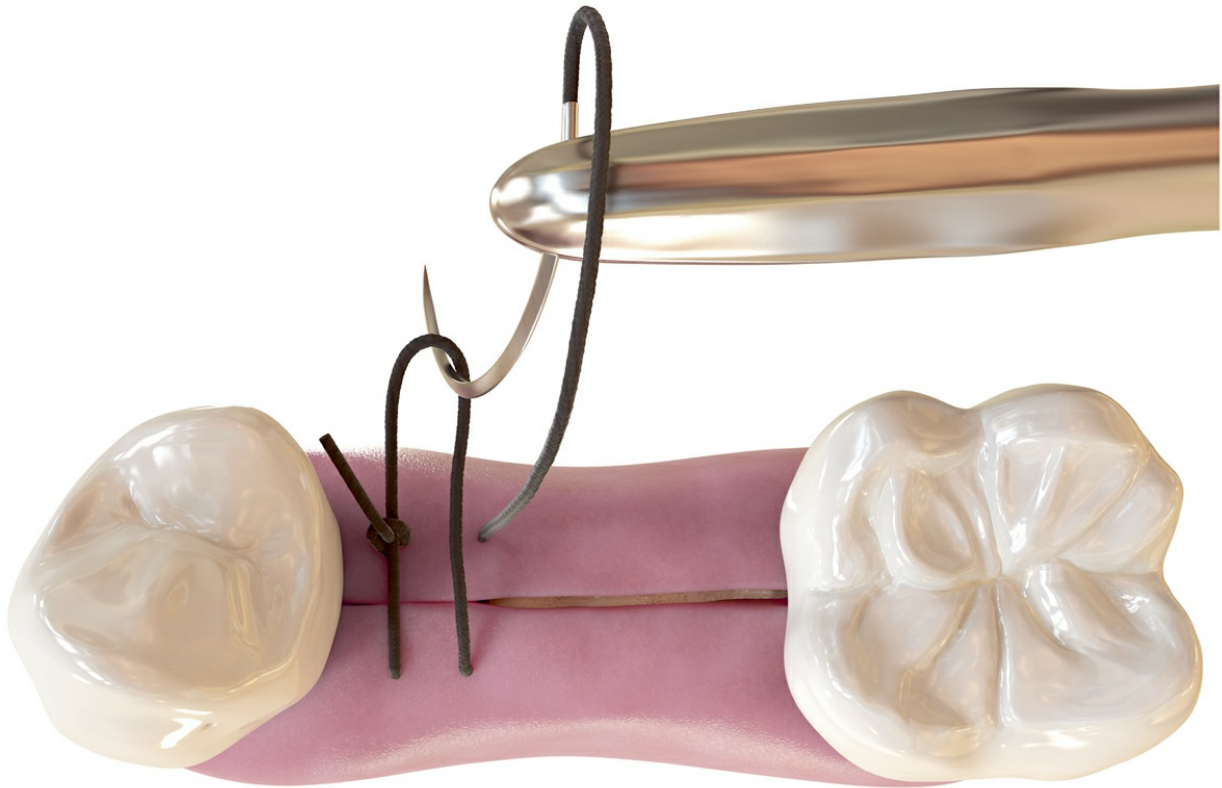


Fig 3-4 (c) The needle is then introduced through the wide loop between the first and second sutures, thus forming a lock.

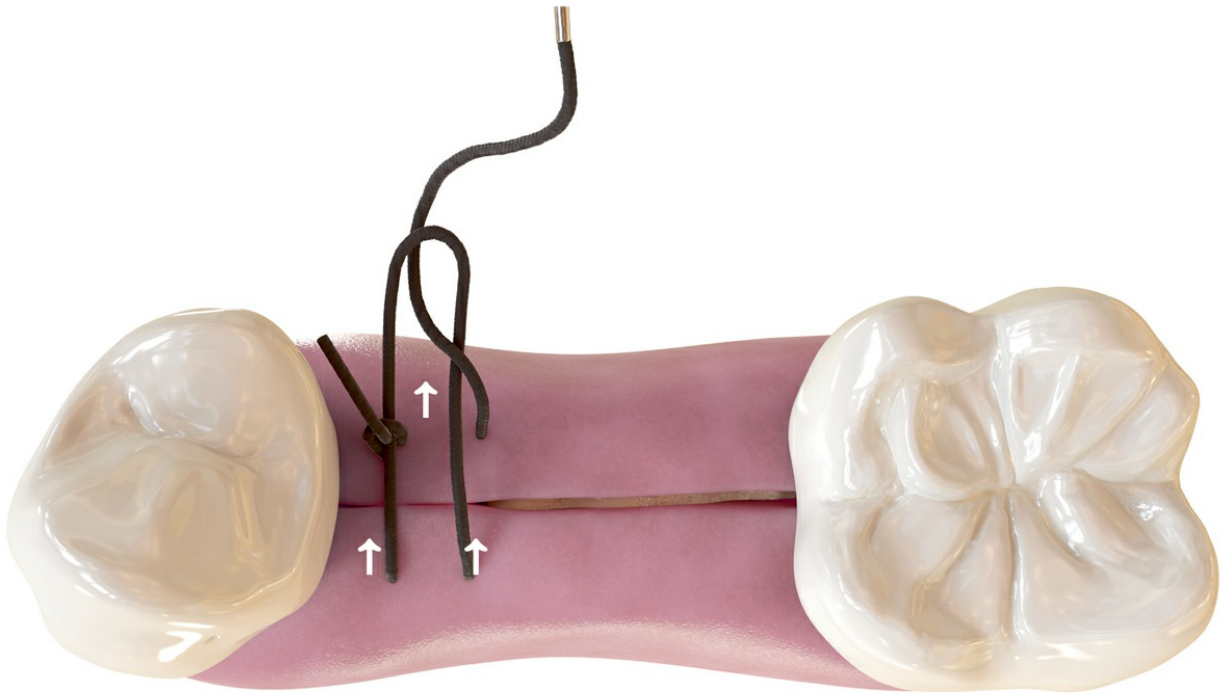


Fig 3-4 (d) Pulling the thread to the immobile side (arrows) moves the lock in that direction. The route in which the needle end passes through the loops determines which side they will rest. It is preferable for the loops to rest on the immobile or keratinized side of the wound. Failing to maintain the same direction of loop crossings will result in the loop resting on the other side.

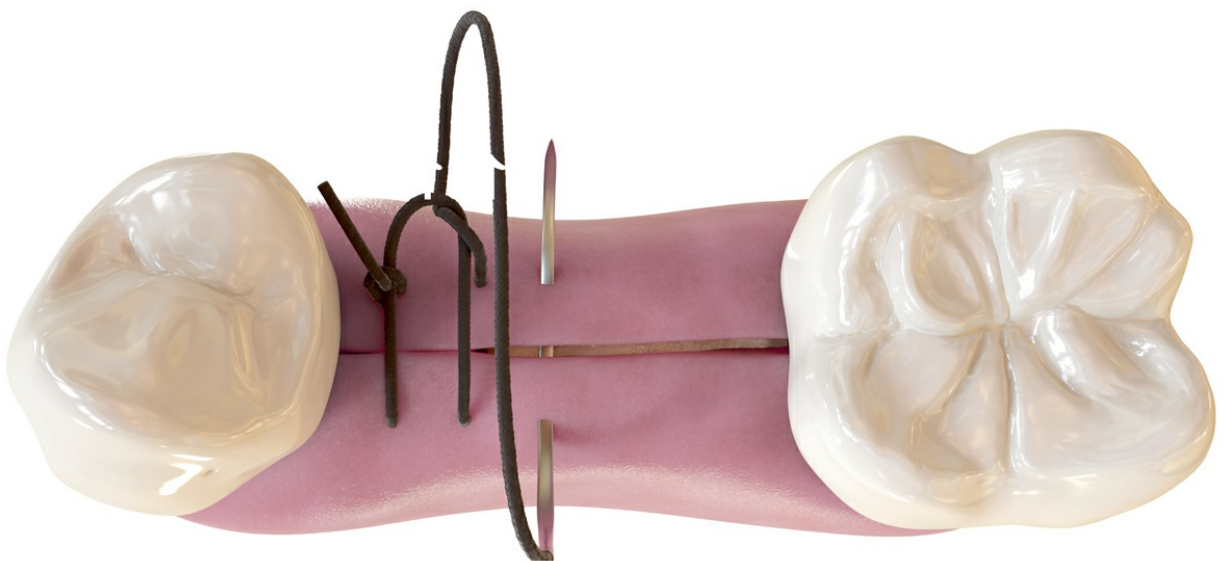


Fig 3-4 (e) With each suture placed, the needle is inserted through the tissues in the same direction.



Fig 3-4 (f) The lock is placed at the immobile side each time, and the procedure is repeated at equal intervals until the end of the incision.

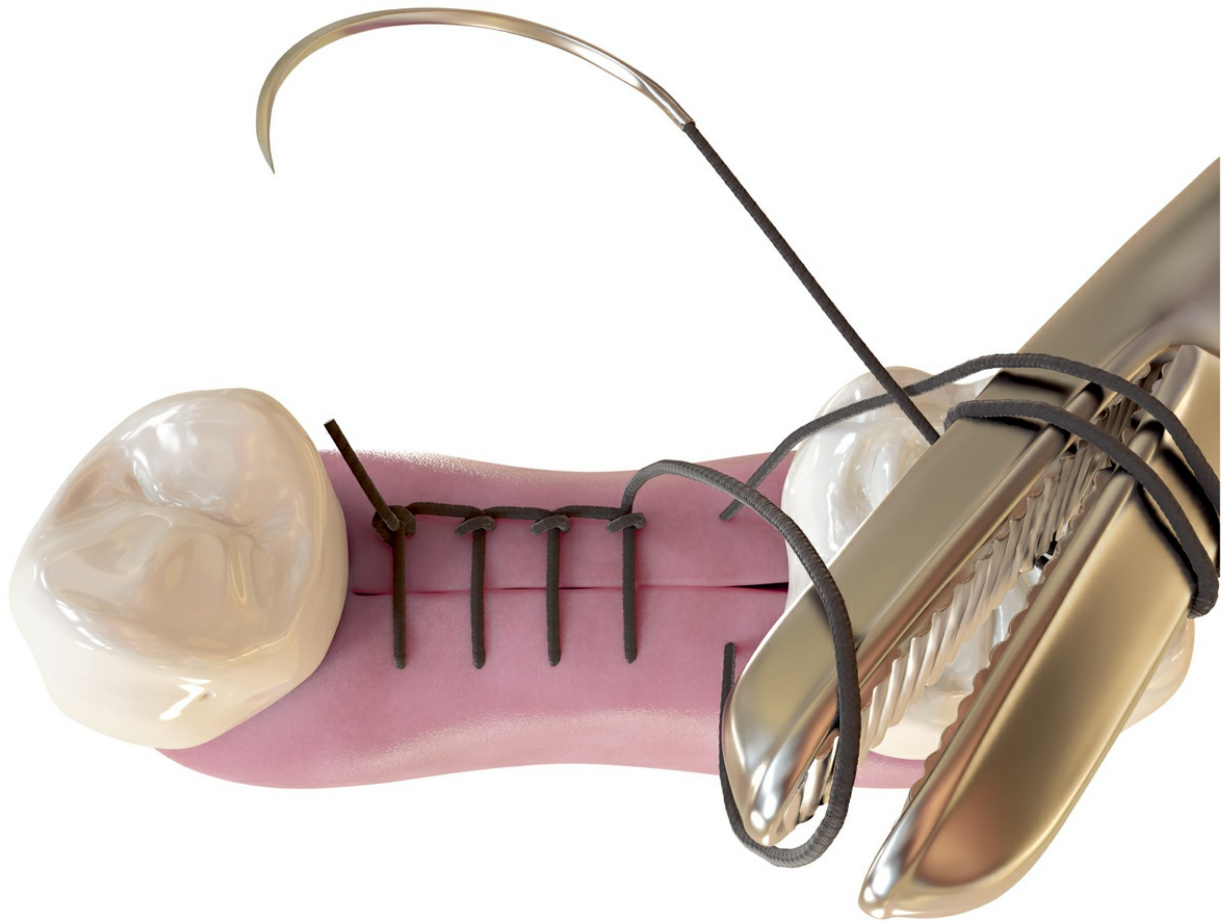


Fig 3-4 (g) Once the final suture has been placed, the single thread positioned at the immobile side is turned twice clockwise around the needle holder. The loop is then held in the middle to tie the knot.



Fig 3-4 (h) In principle, the wound is closed with repeating simple sutures with ears that are not cut, except for the first and last ones. The locks are best placed on the unelevated or keratinized side of the wound, as that side is more resistant to irritation.

The key point of this suture is to pass the needle through the loop in the same direction each time. The direction in which the needle passes through the loop determines the side where the loop will rest. Changing this direction will result in the loop resting on the other side of the incision (Fig 3-5).

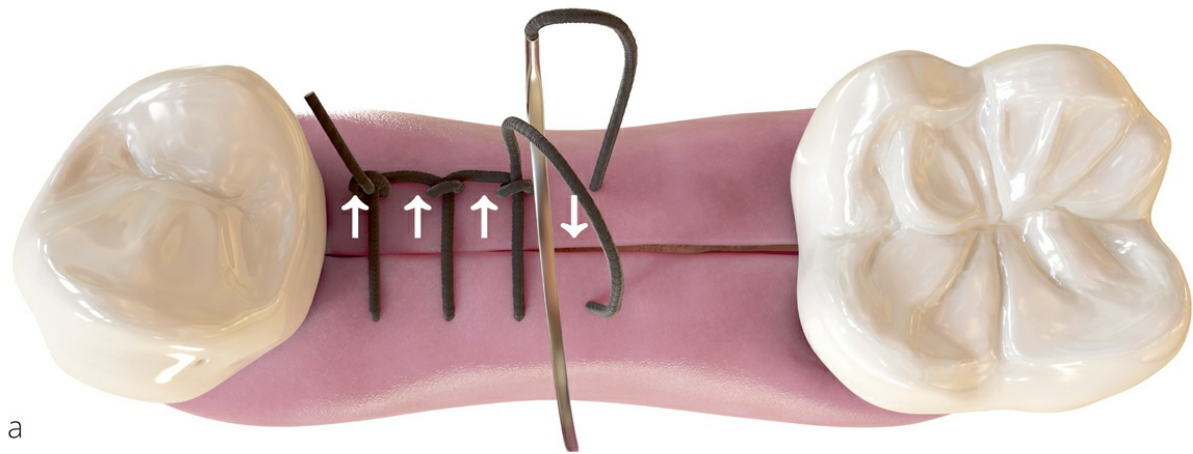
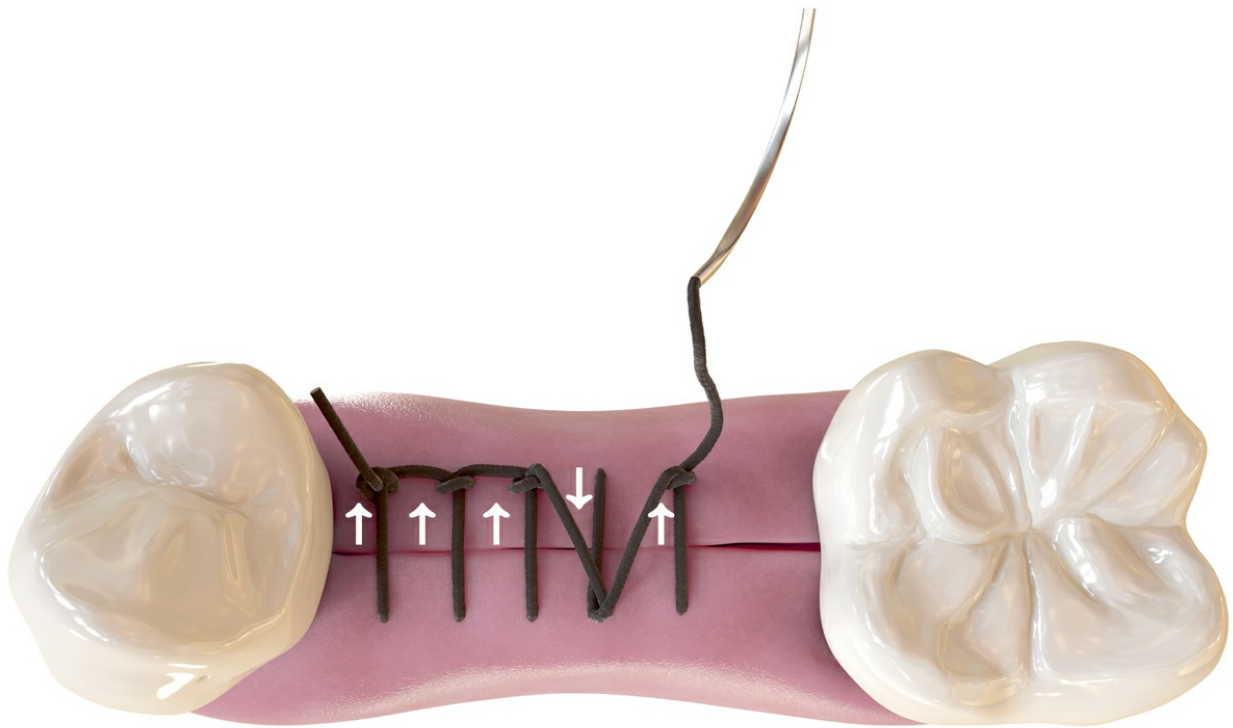


Fig 3-5 (a and b) It is important to ensure that the direction of insertion both through the tissues and through the loop is always from the mobile to the immobile side. If the insertion of the needle through the loop is changed (a), the knot is transferred erroneously to the mobile side (b).



c



d

Fig 3-5 (c and d) This can be corrected by passing from the mobile to the immobile side in the next suture so that the knot ends up on the immobile side again (c). However, such a correction would result in irregularities in the completed suturing (d). Such irregularities result in more thread accumulating on the healing margin of the wound, creating more retentive areas for plaque accumulation.

Corner sutures

Areas of usage

This type of suture is used at the end of horizontal incisions, particularly in long edentulous areas where releasing incisions have been made. Corner sutures are used to distribute the tension evenly to all three wound edges, thus contributing to the improvement of circulation. Although it is possible to close these flaps with individual interrupted sutures, the triangular part of the cleavage often remains mobile, delaying the healing process. The corner suture is used to resolve this problem and to improve corner adaptability.

Advantages

This type of suture holds tissues together, distributes suture tension to the three margins of the wound equally, facilitates better positioning of the tissues, and saves time.

Disadvantages

It is difficult to apply this suture in cases where there is a thin mucosal phenotype.

Technique

Contrary to general suturing principles, the needle is introduced into one of the long wound margins (not the triangular margin created by the cleavage), engaging the tissues from the outer surface and exiting from the inner side. The needle is then passed sagittally at the tip of the triangular flap that remains from the cleavage of the main incision.

This passage takes place in the connective tissue, without engaging the epithelium. In this manner, the triangular tip formed by the cleavage of the incision is pulled in the direction where the two major flaps meet. Finally, the third and other major side of the flap is transversed from the inner to the outer surface. The suture effectively pulls together all three margins, with the same tension introduced to each. A final knot locks the suture. This suture can be used in combination with others such as the simple/locking continuous or interrupted suture. Thin, monofilament suture thread is recommended for this type of suture as the triangular tip is usually very thin and fragile (Fig 3-6).

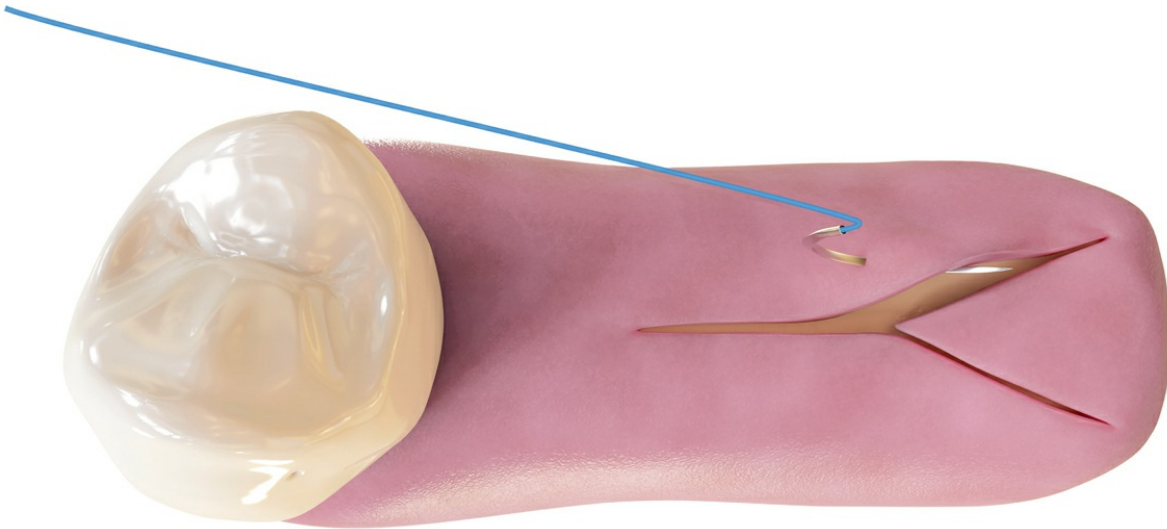


Fig 3-6 (a) The needle is inserted from the outer to the inner surface of the flap, parallel to the main incision, leaving from the releasing incision on the respective side. Although this can be initiated from either side of the incision, starting from one of the long wound margins (as opposed to the triangular margin created by the cleavage) makes it easier to carry out the next (difficult) step of the maneuver.

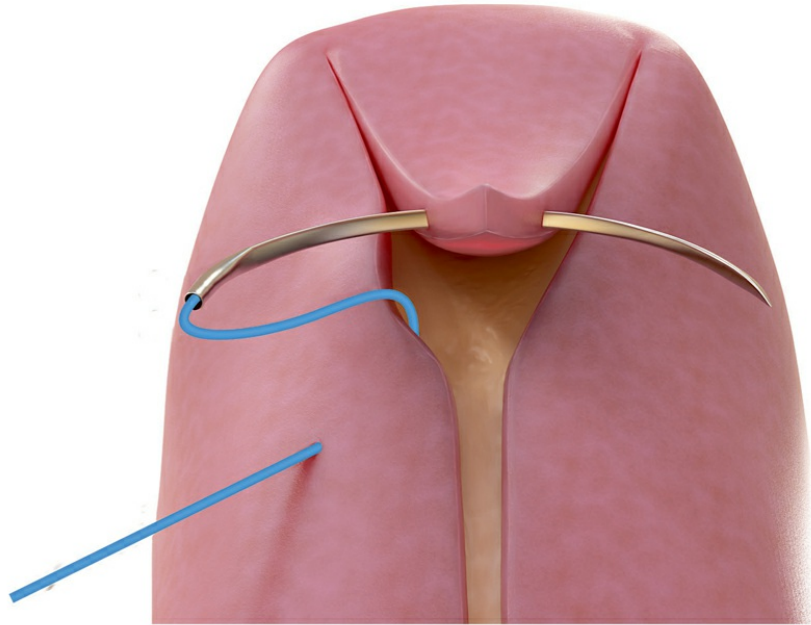


Fig 3-6 (b) The needle is inserted through the submucosal tissue, epithelial surface. It is recommended that thin suture threads be used with this technique since the volume of this tissue is limited.

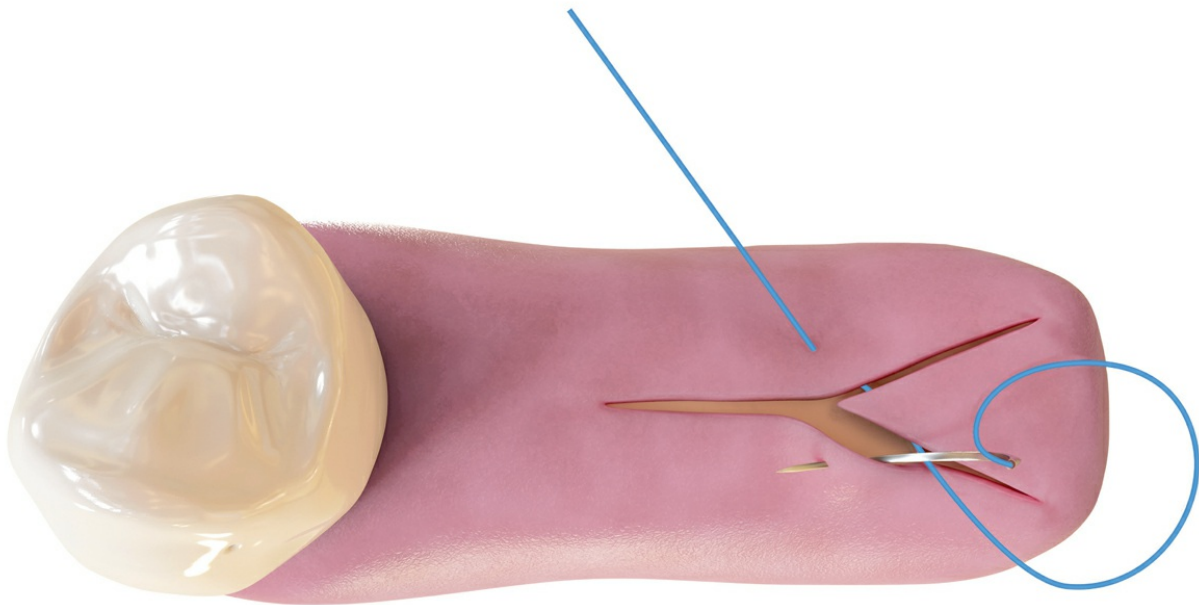


Fig 3-6 (c) The needle is then inserted through the contralateral side of the main incision, from inside to outside.

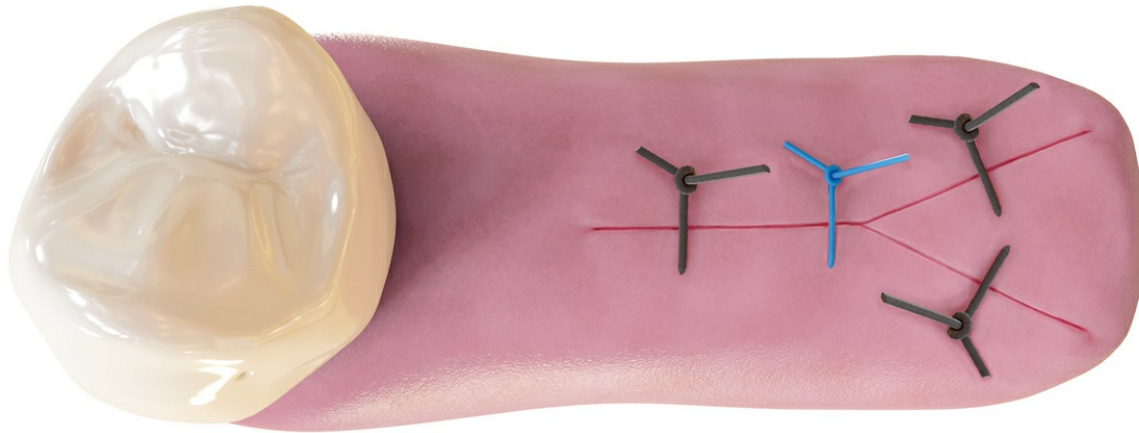


Fig 3-6 (d) All margins must be fully adapted to one another by accessory sutures.

DISPLACEMENT SUTURES FOR APPROXIMATING WOUND MARGINS

Areas of usage

Good circulation or blood supply is a major factor in uneventful wound healing. Applying tension to the tissues on a continuous basis impairs circulation. Therefore, the presence of sutures on wound margins that compress the healing site adversely affects healing. For this reason, the tissues first need to be approximated with a suture that does not induce compression at the healing margin. The incision should then be sealed separately to maximize the healing potential of the tissues. This would help to remove the compression caused by the suture under tension away from the healing wound margin, as the sutures at the margin would not bear any load and so would promote passive adaptation.

Square sutures are thus named because they engage the tissues four times, twice on both sides, forming a square shape with respect to the bites. Mattress sutures are inspired by, and were designed based on, the sutures performed by mattress artisans in days gone by – hence their name. Although there are several varieties of this technique, it is basically divided into two main categories: vertical and horizontal. Vertical mattress sutures are used in cases where the tissue thickness is sufficient, and the tissues tend to curl inward or to slip on each other vertically. It has very limited usage in dentistry. Horizontal mattress sutures can be simple or locking. The locking version facilitates easy removal of the sutures. With the simple version, however, where the flap is released and approximated it becomes difficult to find the ears as they become embedded in the tissues due to postoperative edema.

Advantages

In this technique, tissues that are released and displaced are not engaged from a single point. This distributes the tension evenly at each bite. In addition, two wound margins can be fixed with surface contact rather than with end-to-end contact, enhancing perfusion at the margin by increasing the surface of connective tissue contact. It should be borne in mind that the flaps should be properly released for the suture to achieve displacement.

Disadvantages

The only disadvantage of this type of suture is experienced with the simple version, as it usually becomes embedded in the tissues due to postoperative edema. This makes it difficult to remove the sutures, which is also painful for the patient. This disadvantage can be countered by a later removal of the sutures or by using the locking version.

Technique

Vertical mattress sutures

These are also called Donati sutures after the Italian surgeon, Dr Mario Donati, who was the first person to apply this technique. They are used to approximate thick tissue layers. They are referred to as vertical, not because of the position of points in relation to one another where the suture is introduced to the tissues, but due to the position of the suture crossing the incision in the middle to avoid the overlapping of individual layers. During the learning phase, the mnemonic 'far-far-near-near' can be used to remember the points of insertion of the needle into the tissues, indicating the order of bites of the tissues by the needle. Although this type of suture is not commonly used in dentistry, it can be used to approximate retromolar thick tissue or the papillae of thick palatal flaps. This type of suture requires a thick tissue biotype as it passes between the tissues (Fig 3-7).

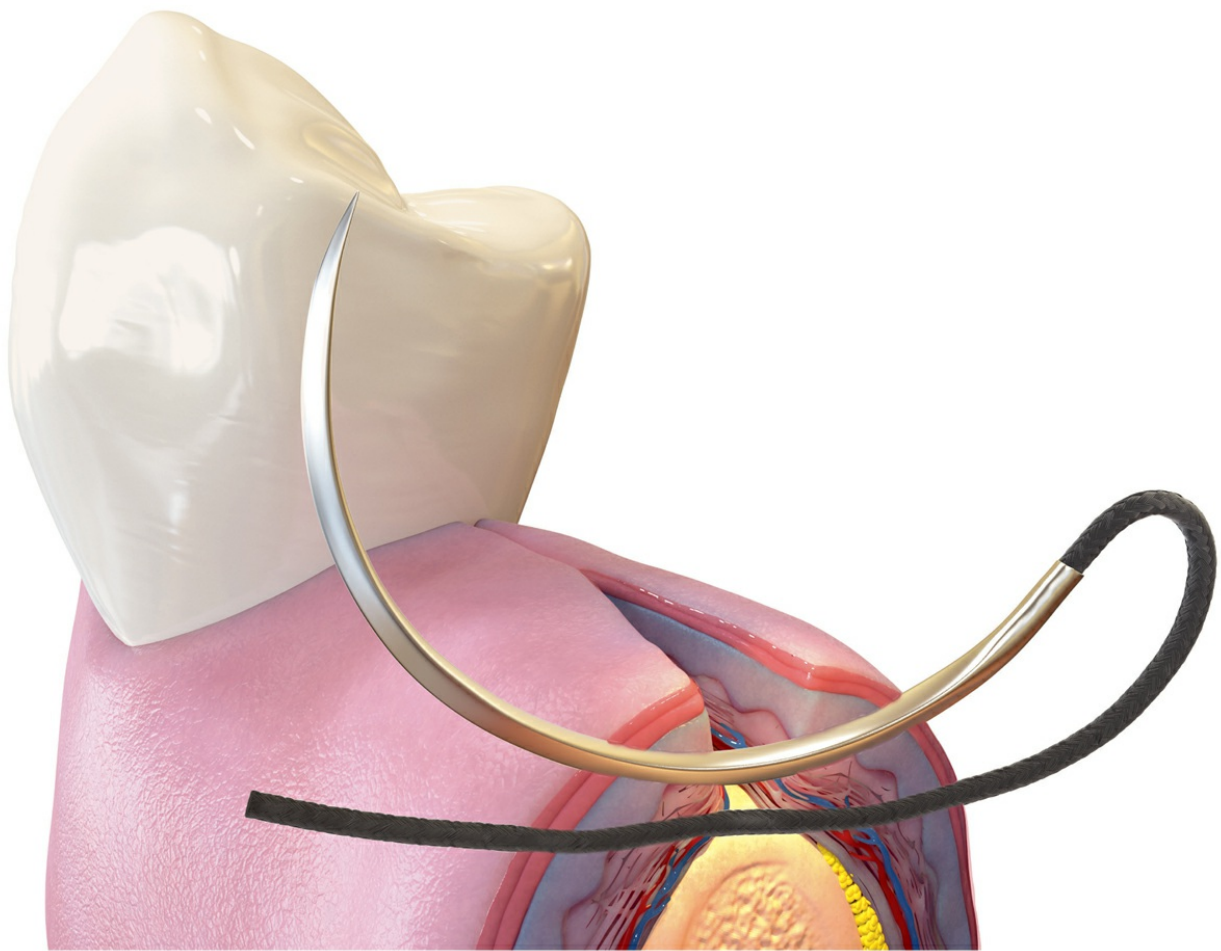


Fig 3-7 Starting from the mobile side, the needle – which is introduced into the tissues at a point far away from the wound margin – leaves the flap close to the incision but on the interior side of the wound. The suture transverses the other side of the flap, leaving the opposite flap at a comparable distance from the margin as the counterpart. At this point, the ‘far-far’ step has been achieved. Then, the needle is inserted into the tissues at a point that is closer to the incision, leaving the tissues from the cut wall near to the surface. The needle is then engaged at the corresponding margin at a similar depth and leaves the surface closer than the first bite with respect to the incision. This is the ‘near-near’ step. Since the pull is distributed to four different bites and two vertical levels, this suture prevents the tissues from overlapping and impairing their nourishment.

Horizontal mattress sutures

This type of suture engages both sides of the incision at two points. It is primarily used to remove tension from the wound margin, thus ensuring sufficient blood supply where it is needed most. If there are underlying membranes, the part of the suture that travels under the flaps facilitates better adaptation of these membranes. This suture also folds the margin of the wound externally, consequently increasing the area of contact of the connective tissue surfaces at each side of the wound. Nevertheless, wound closure sutures are still needed to seal the wound margin, and for this purpose interrupted or continuous sutures may be used (Fig 3-8).

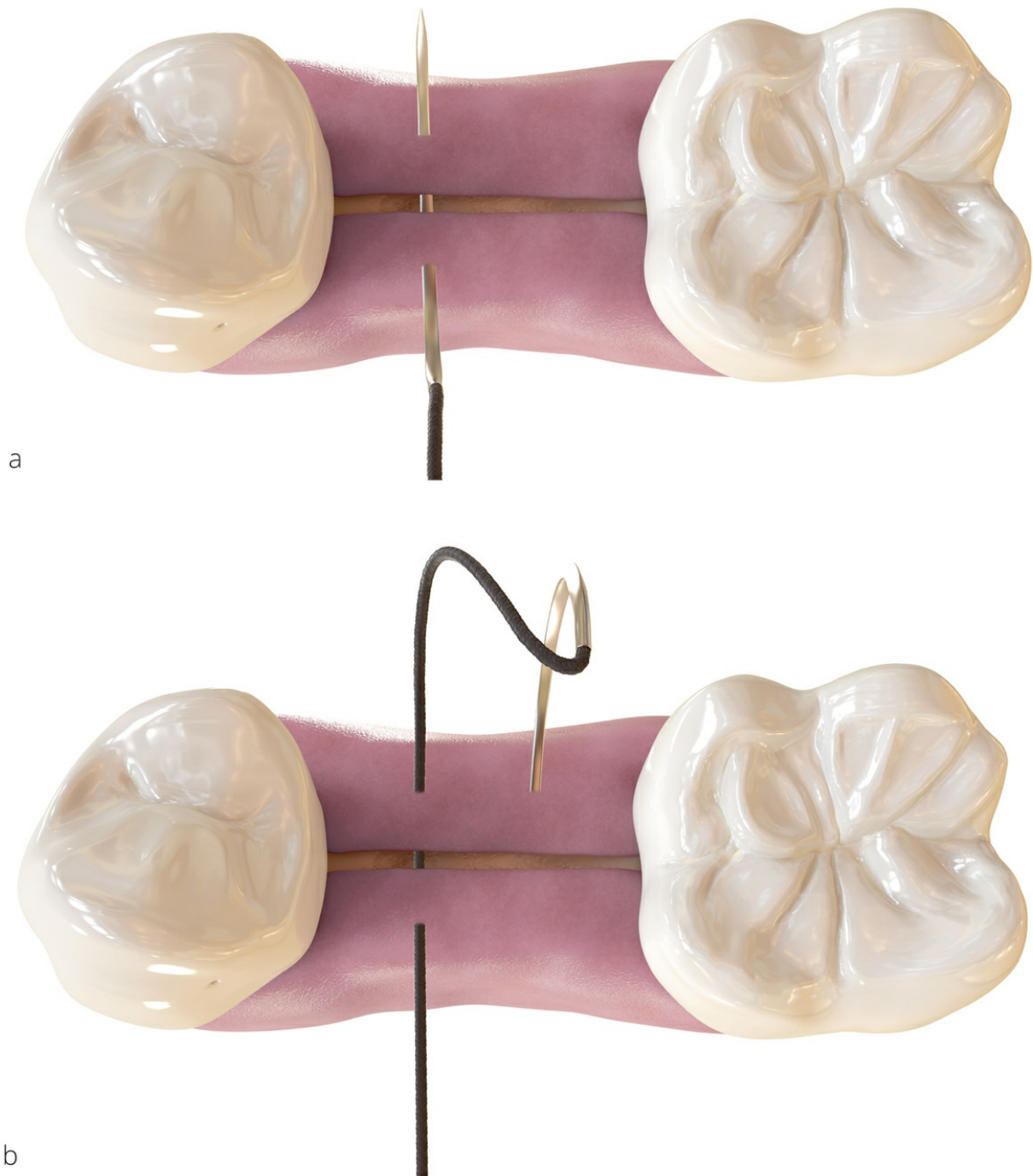


Fig 3-8 (a and b) The first step is exactly the same as that of a simple suture, where the needle bites from the outer surface at the mobile side, and from the inner surface on the other side (a). Without fastening a knot, the needle is advanced for the next suture, leaving a loop of thread between the two (b).

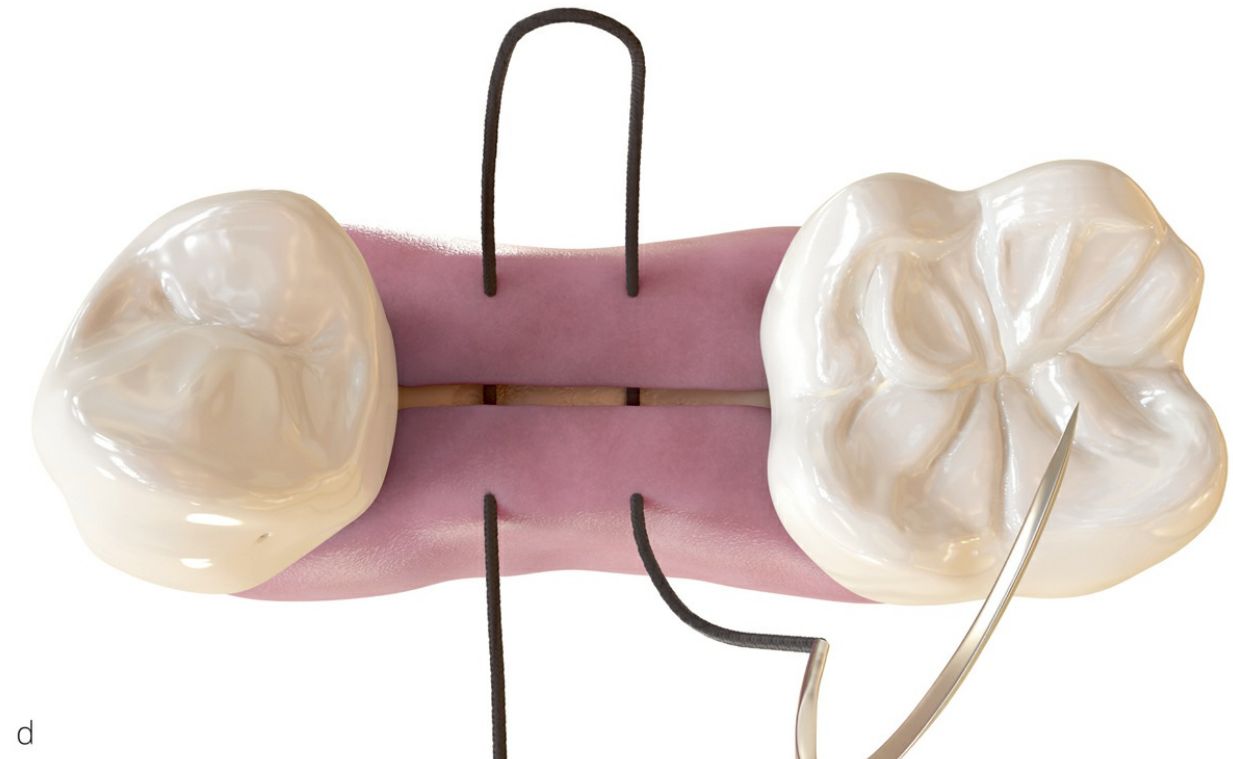


Fig 3-8 (c and d) With the second suture in its place, a loop is formed between the two sutures. This loop may be used to tie a marker (see Fig 3-8f) or for locking (see Fig 3-9).



Fig 3-8 (e) The suture is secured by tying a knot. It should be remembered, however, that this suture may be embedded in soft tissue due to postoperative edema, thus making it difficult to remove.



Fig 3-8 (f) A different-colored thread can be tied to the loop to overcome the problem of embedded sutures, making it easier to locate the suture to remove it. Another option is to use the locking version of this suture.

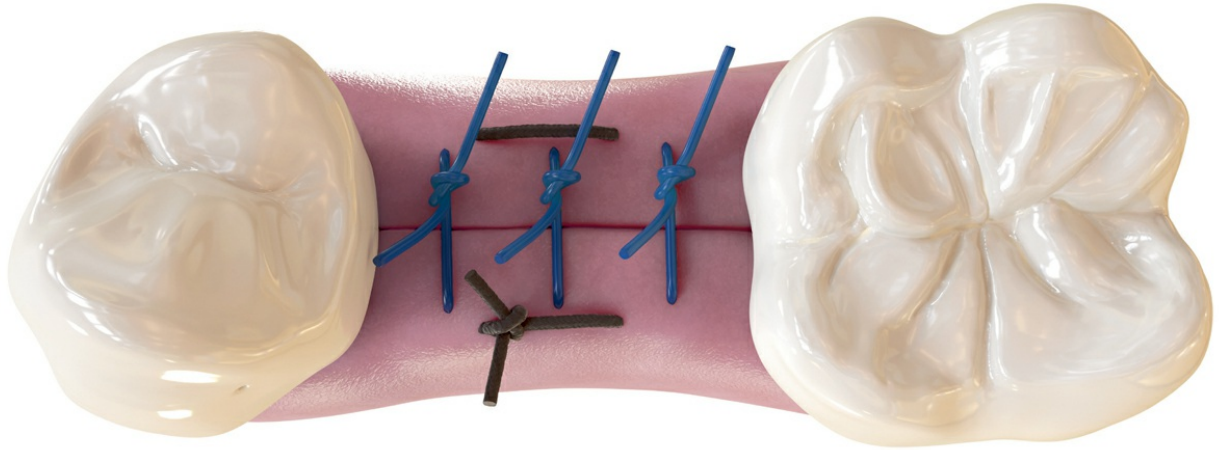


Fig 3-8 (g) Although the mattress suture approximates the wound margins, it does not help to seal the incision. The wound needs to be sealed by either simple or continuous sutures.



h



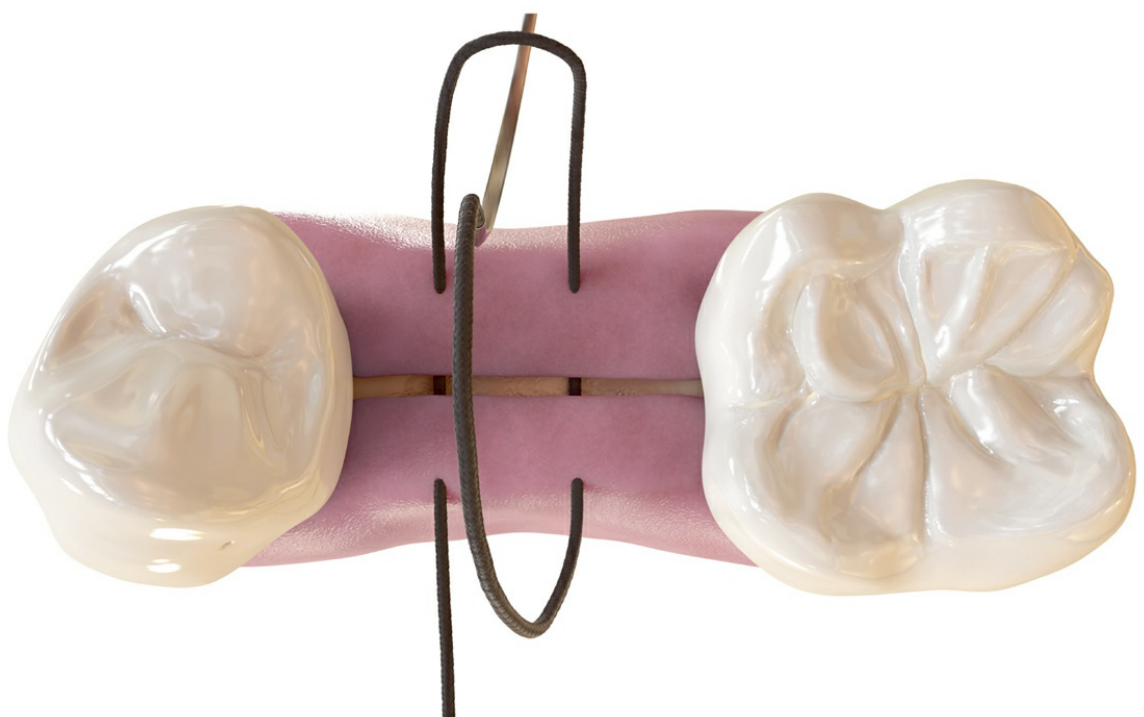
i



Fig 3-8 (h and i) The bite positions of the needle need to be located away from the wound margins, thus elevating the tissues to increase the contact surface area of the flaps. In addition, this helps the clinician to locate some free space to place interrupted sutures to seal the wound margin.

Locking horizontal mattress sutures

These sutures, also known as Laurell-Gottlow sutures, are a modification of horizontal mattress sutures with a lock that prevents them from embedding in the tissues. This suture is performed by going through the loop between the second and third bites with the needle end, then tying it with the ear. It is recommended to use additional interrupted sutures to avoid dehiscence at the remote corners caused by locking, which results in the central pull of the suture (Fig 3-9).



a

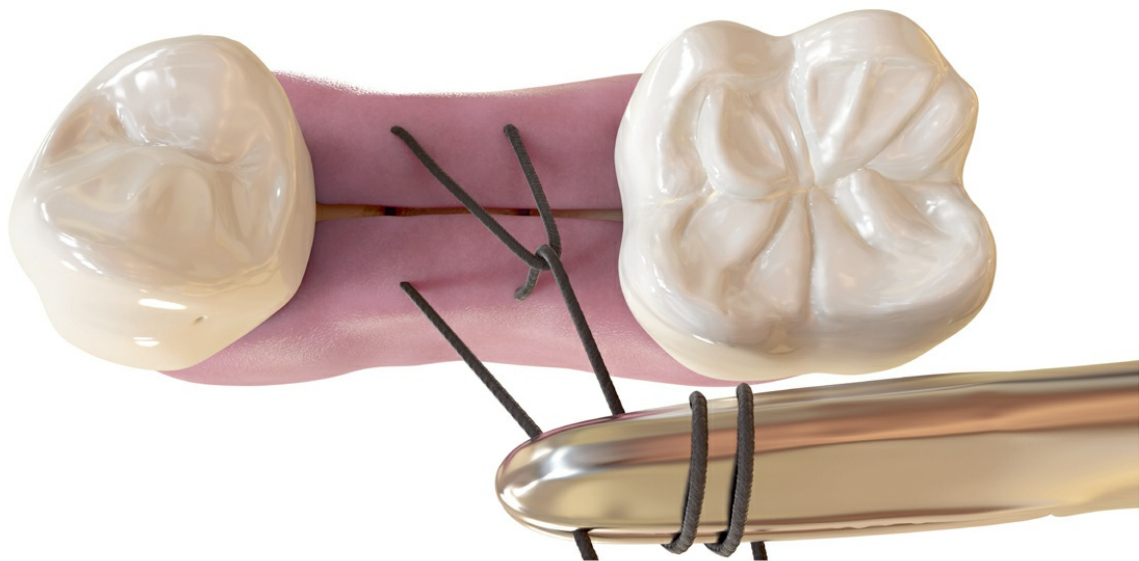




b



c



d

Fig 3-9 (a to d) Locking horizontal mattress suture. The same steps are followed as those performed for the horizontal mattress suture. Just before tying and securing the suture, the needle is passed through the loop formed at the other side to build a lock.



Fig 3-9 (e) The lock is pulled toward the mobile side and tied.

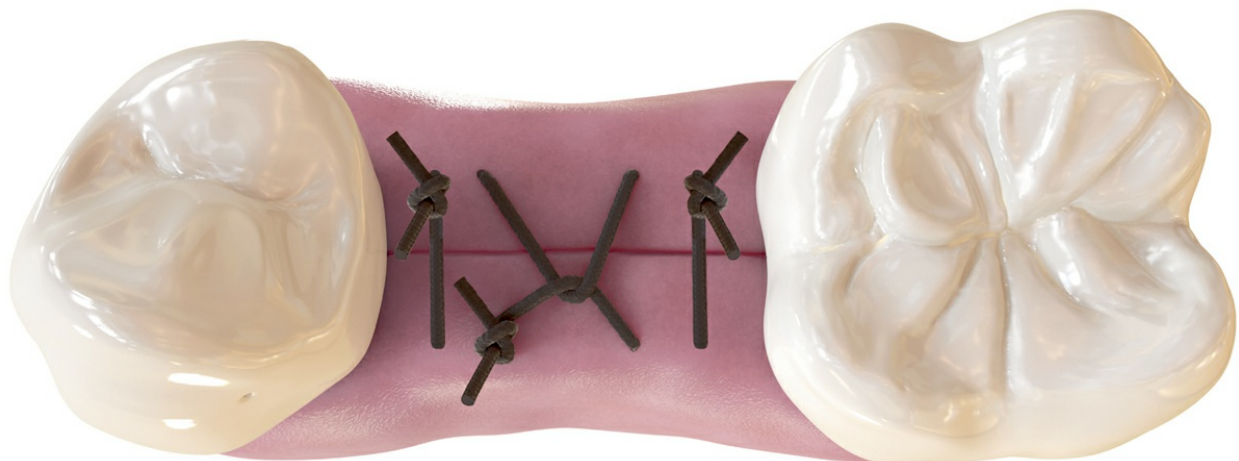


Fig 3-9 (f) The locking mechanism adds an interrupted suture to the simple horizontal mattress suture. However, the central pull results in dehiscence at the remote corners. This problem can be resolved by using interrupted sutures at these corners.

SLING SUTURES

These are the type of sutures where soft tissue is positioned by the anchorage taken from the teeth, contact points, brackets, or even resin-based restorative materials.

Areas of usage

There are two main types of sling sutures. The first type is used to position the tissues at their original location. In this type, there is no tension on the suture or the tissues. The second type is used when tissues are relocated coronally and there will be a buildup of tension both on the suture and the tissues. This requires necessary measures to be taken to overcome the problems associated with such tension.

Advantages

Sling sutures simplify suturing in cases where coronal advancement is not attempted, and a one-sided flap is elevated. In such cases, the suture requires the presence of two papillae on both sides of the tooth. The suture can be further modified to extend to other papillae as a continuous suture. A single sling suture has a positioning capacity equal to that of two interrupted sutures, which saves time, simplifies the surgeon's task, and positively affects wound healing, since no tissue bite is necessary at the unelevated side. When used to relocate tissues, the suture will pull the tissues to the level of anchorage. Under such tension, engaging the tissues with two bites at a distance from the wound margin will improve blood supply where this is most needed.

Disadvantages

Engaging the flap at a single point impairs circulation in cases where the suture is under tension. Damage to the anchorage points (if used) by the masticatory function will loosen the suture. Therefore, the occlusion must be checked for early contacts before building up anchorage points.

Technique

To perform one-sided flap elevation

This technique can only be used if the flap is elevated only on one side of the ridge. It requires at least two neighboring papillae. This type of suture saves time as it slings two neighboring papillae on the cervix and requires only one knot. The thread should engage both papillae at their base and should not go through the papilla on the other (palatal or lingual) side. There are no individual sutures required since the slinging part of the suture adapts the papillae to the interdental space (Fig 3-10).

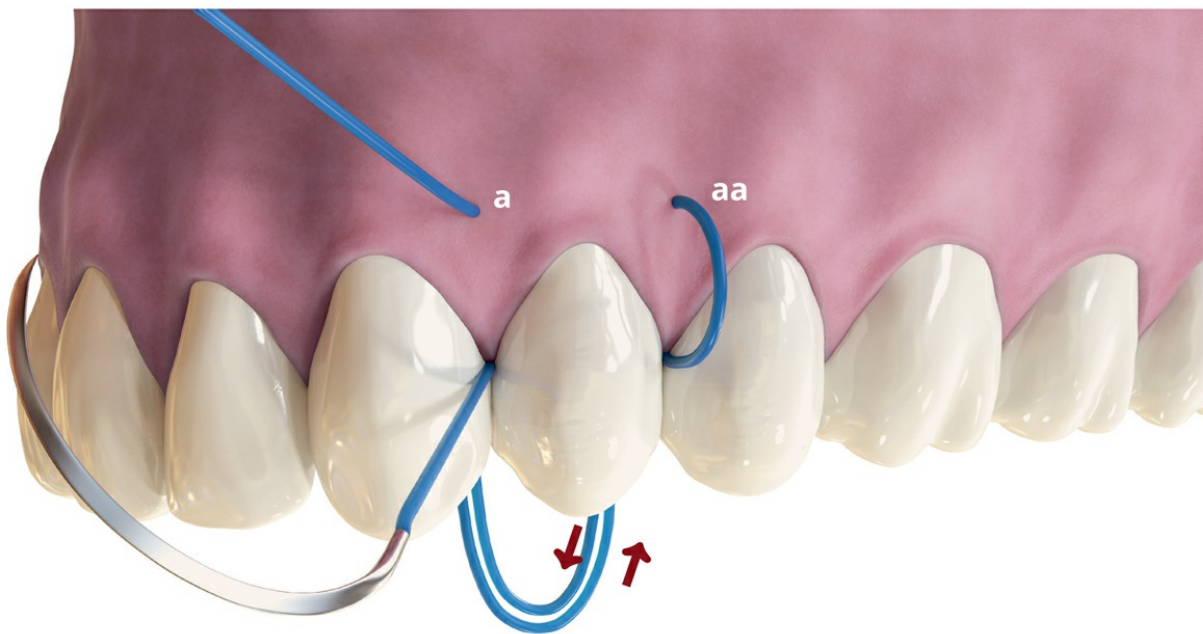


Fig 3-10 (a) The sling suture fixes two adjacent papillae to the neck of the tooth. It is introduced at the base of one of the papillae [a], crossing to the palatal/lingual side from the interdental space without engaging the papilla itself. After traveling around the neck of the teeth at the palatal/lingual side of the tooth, the suture is transferred to the vestibular side of the corresponding interdental space, without engaging. The papilla of the adjacent side is then included in the suture [aa], where the suture travels back to the initiation point [a] along the same route.

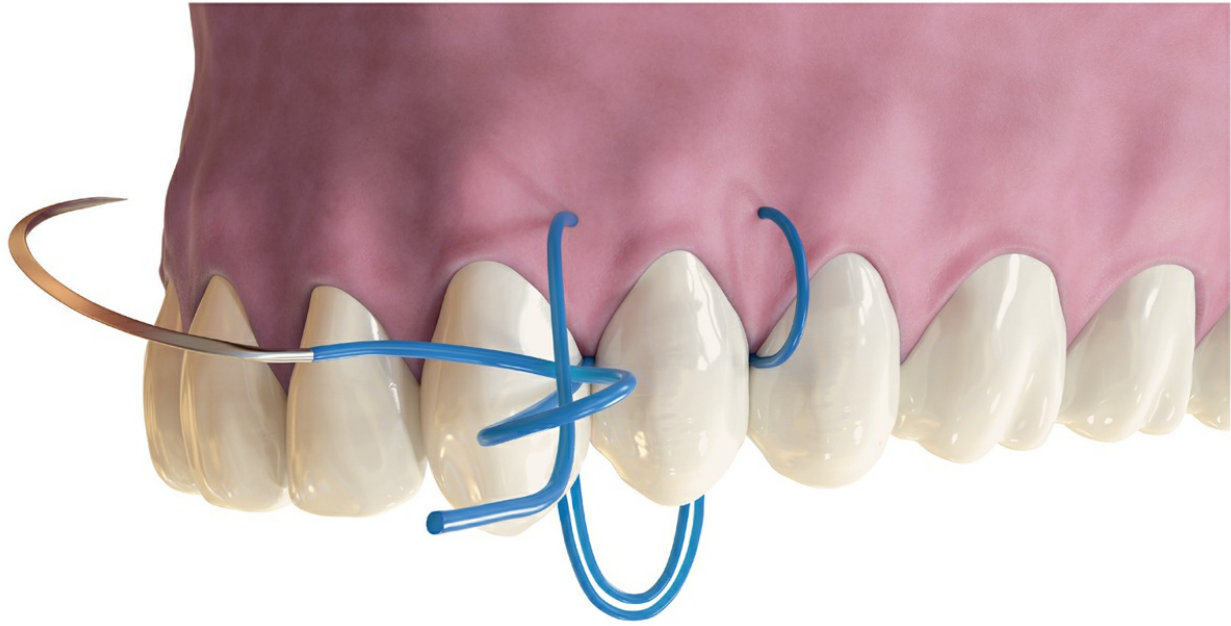


Fig 3-10 (b) The suture, which is moved back to the point of origin, should not be inserted through the flap again after this point. The most common mistake made here is to bite the flap once more. The suture is locked by a surgical knot.

To move the tissues coronally

Sling sutures are often used to cover gingival recession and to displace the gum further coronally compared with its preoperative position. Although there are several variations of the technique, the basic principle is to engage the flap at two points to avoid the impairment of blood supply due to the tension created by pulling the threads. These two points should be at a safe distance from the wound margin. In this technique, the anchorage is maintained by the interproximal bone. Thus, the extent of coronal displacement is limited to the height of the interproximal bone. This is not a wound closure suture, and the wound needs to be closed by interrupted sutures. Since the main purpose of this suture is to relocate the tissues at a different position, it is imperative to remember to take the necessary measures to release tension from the flap (Fig 3-11).

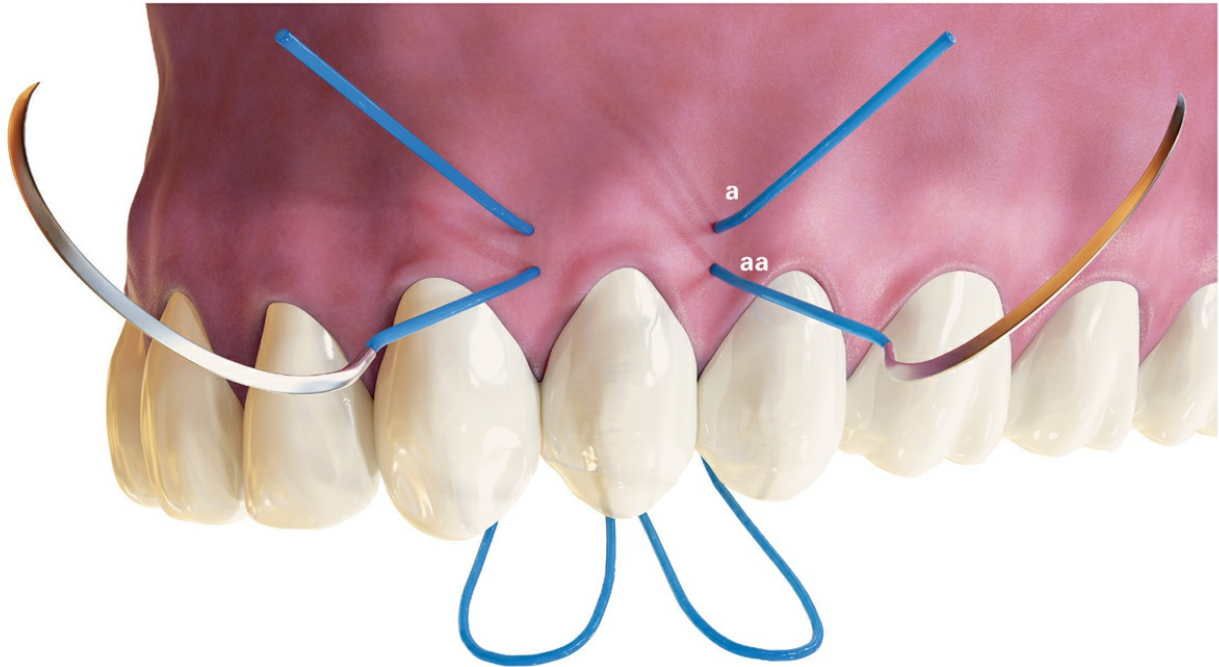


Fig 3-11 (a) This figure illustrates two separate sutures displacing the flap coronally to cover the recession at the premolar teeth. The point at which the suture is started [a] is located at a safe distance from the healing site of the gingival margin, as the tension to be exerted on the tissues by locking the suture with a knot will hamper adequate blood in that direction. The suture passes through the flap from the outside to the inside, crosses the interdental space from the base of the papilla, and leaves the tissues at the base of the palatal papilla. The needle is reinserted through the base of the same papilla, at a point close to the point where it leaves. It then travels over the interdental bone and under the papilla to the vestibular side, where the buccal flap is engaged from the inner surface to the outer at a point where the suture was initiated [aa]. Rather than being anchored by the cervicals of the teeth as with other sling sutures, this suture is supported by the interdental height of the alveolar bone, i.e. the coronal displacement is limited by the interproximal bone level. When considering the points through which the suture passes inside the tissues, this suture lies on the vertical plane, allowing vertical displacement of the tissues.

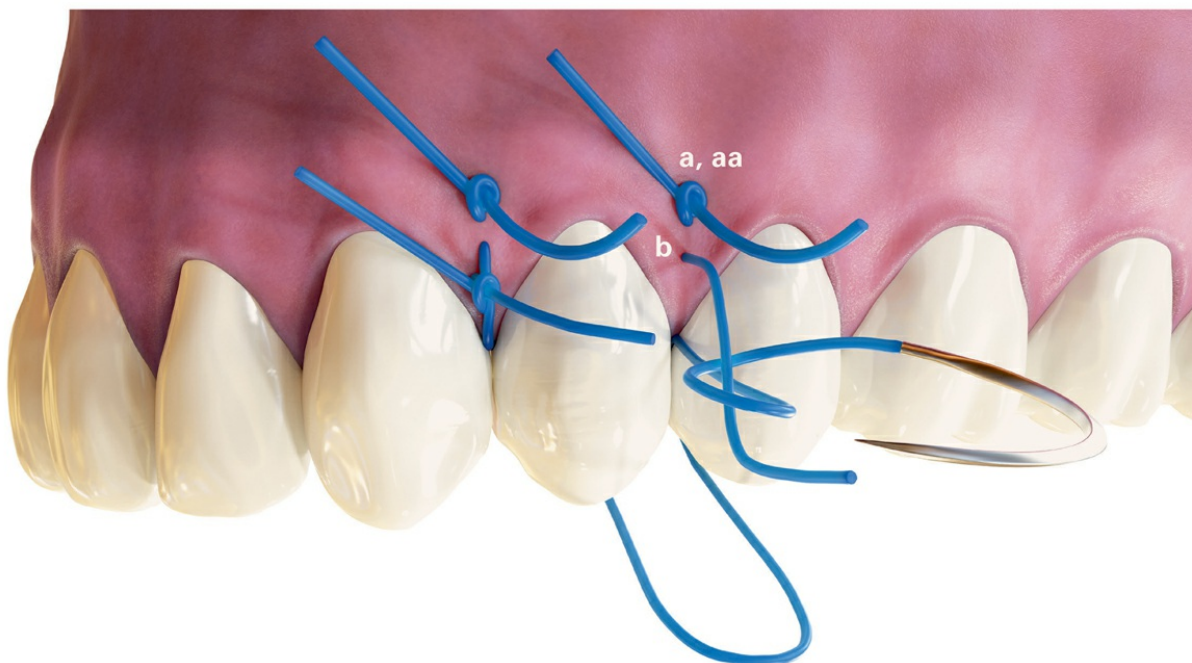


Fig 3-11 (b) Papillae of the flap displaced coronally with the mattress suture are closed by interrupted sutures [b].

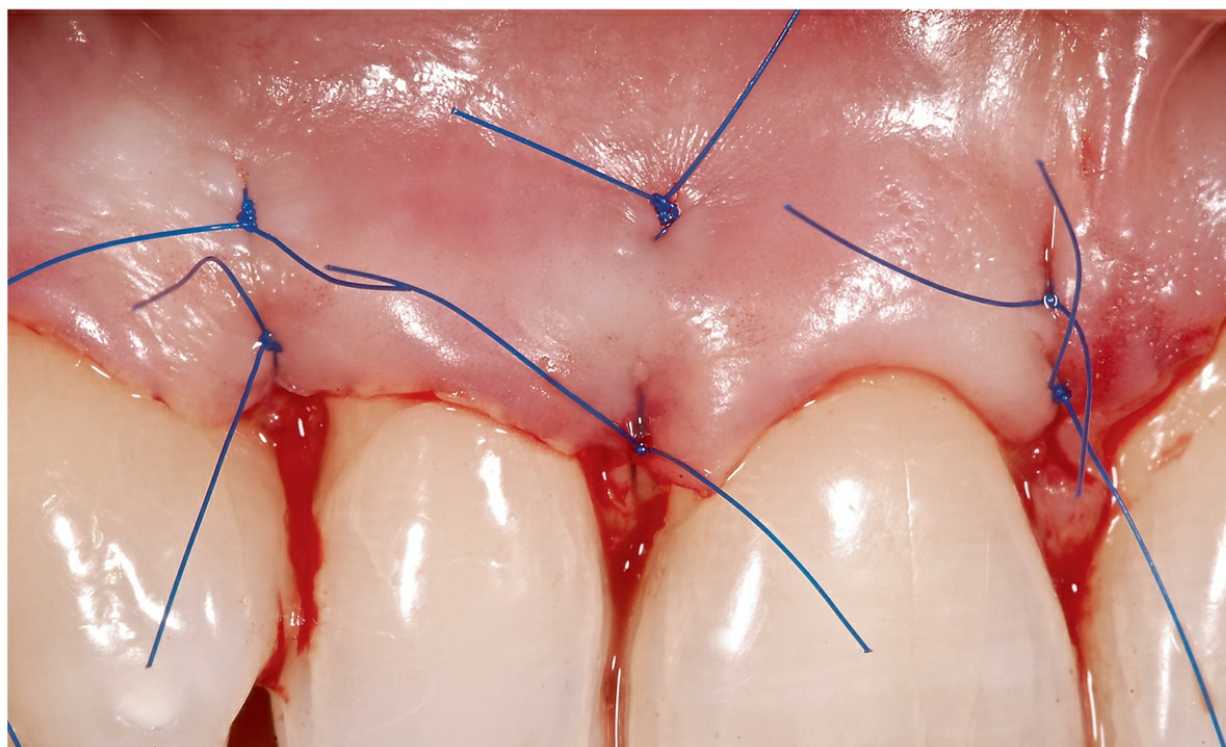


Fig 3-11 (c) This clinical image shows the mattress suture relocating the flap coronally, and interrupted sutures closing the wound. It is critical to place the mattress suture at the base of the papilla, at a safe distance from the area where wound healing will take place, and use interrupted sutures at the passively rested papillae. The two determinants of the extent of coronal displacement are the interproximal bone level and the point at which the mattress suture engages the flap. Excessive tension on the suture displacing the flap to the coronal will cause the suture to be embedded in the tissues, as shown here. To ensure uneventful healing, the interrupted sutures that close the wound at the tip of the papillae should bear no tension.

VIEW-ENHANCING (TISSUE RETRACTION) SUTURES

Areas of usage

These sutures are used to retract the flaps to maintain a better view of the working site. They are temporary in nature; therefore, the expectation is that the suture will function as soon as the first knot has been tied. They are mostly used in procedures where the view of the working site is limited such as for regenerative periodontal applications where hemostasis is vital, surgical removal of irritation fibroma, and sinus elevation procedures. They are also used to keep the tongue away from the working site when operating on a patient who is under general anesthesia.

Advantages

This type of suture controls the bleeding and helps to prevent collateral damage by maintaining a clear view of the working site. It has the added advantage of freeing the surgeon's one hand, which would otherwise have been used to hold an instrument. It thereby enhances the working conditions and reduces surgeon fatigue.

Disadvantages

This type of suture creates new bites in the tissues. Carelessness may result in the tissues tearing due to excessive tension.

Technique

Multifilament threads are mostly used for these sutures due to their load-bearing and temporary nature. It is possible to use neighboring soft tissue as a point of support for the constant pull on the tissues to which it is attached, or this support can be achieved by wrapping the thread around the opposing teeth. A hefty surgical tool could also be attached to the end of the thread, if necessary, if the pulling force is to be exerted from outside the mouth. It is recommended to use at least a 3-0 suture thread to route the suture at least 6 to 7 mm away from the wound margin in order to avoid rupture due to the force of the pull (Figs 3-12 and 3-13).



Fig 3-12 (a) The needle is passed through the elevated flap at least 6 to 7 mm away from the gingival margin.



b



c

Fig 3-12 (b and c) A second bite would enhance anchorage, thus helping to prevent the tissues from tearing.

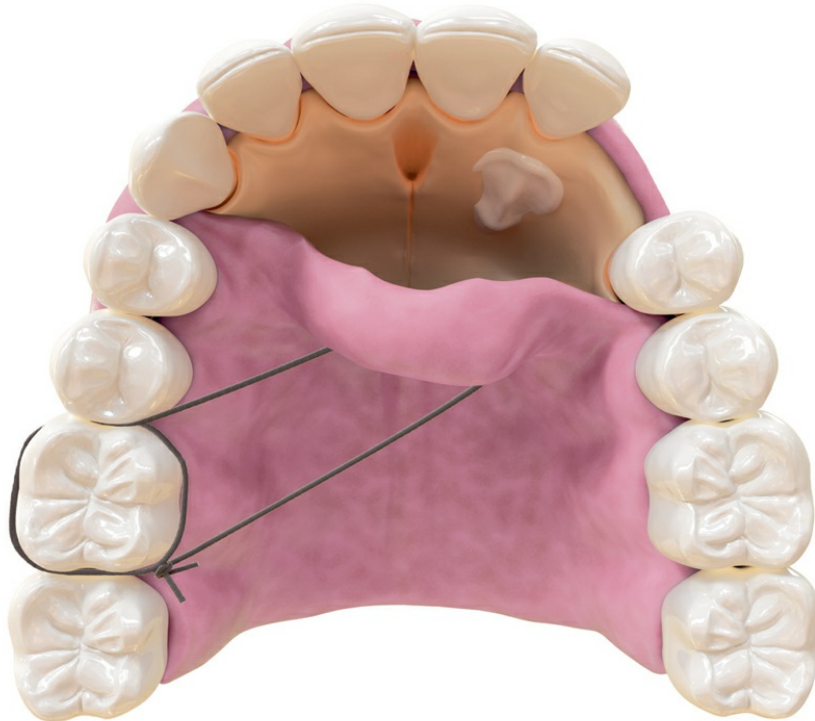


Fig 3-12 (d) Both ends of the suture are pulled to elevate and maintain the flap at the desired position. The thread anchors on a tooth or on any anatomical feature that will not be affected by the tension on the thread.

e

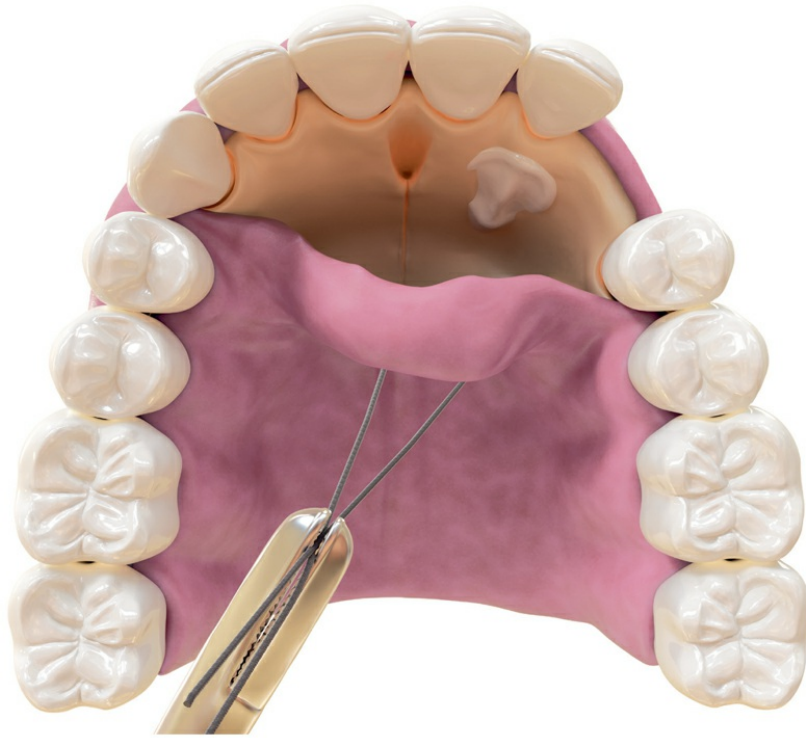
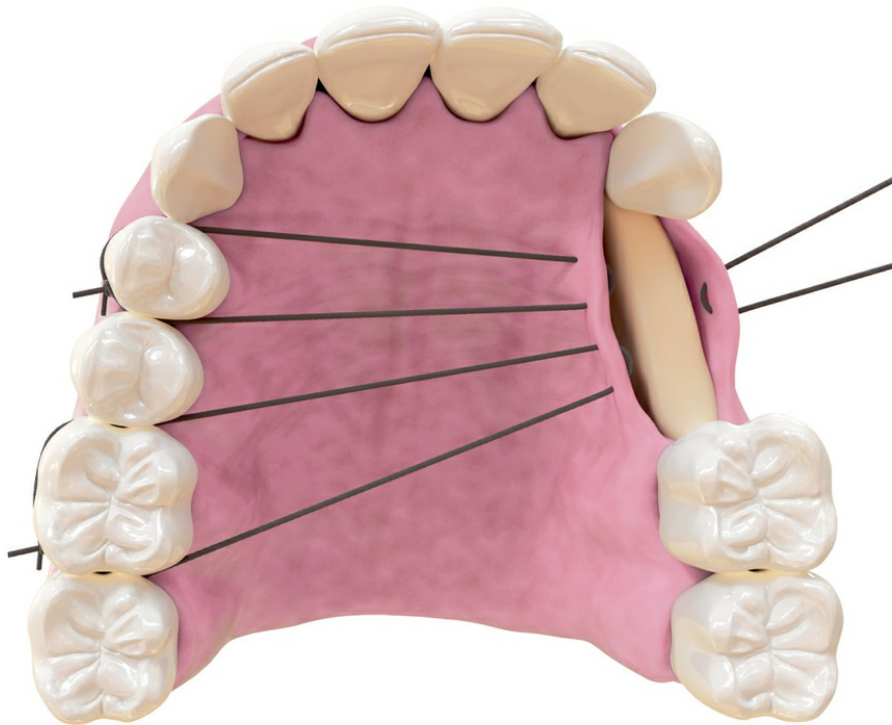


Fig 3-12 (e) The suture elevating the flap may also be held and pulled by a suture holder.

f



g

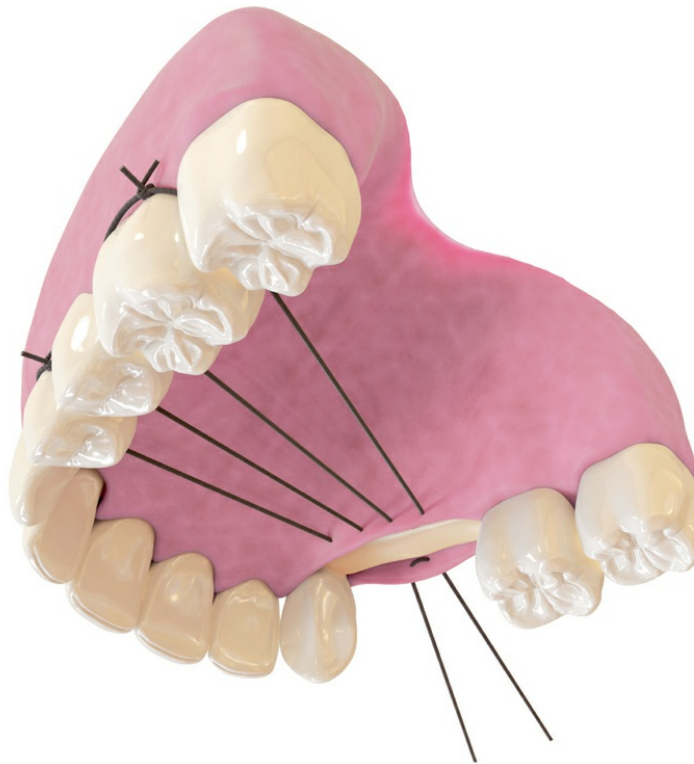


Fig 3-12 (f and g) If a sufficient view of the working site is not offered by retracting the tissues at a single point, additional retraction sutures

may be used. Leaving a distance between the teeth that are used as anchorage points would allow for the pulling of a larger mass of tissues. This would also prevent the risk of the threads kinking, which would cost time. Similarly, the tissues elevated on the other side would be fixed to the buccal side, offering a comfortable operation area for the surgical team.

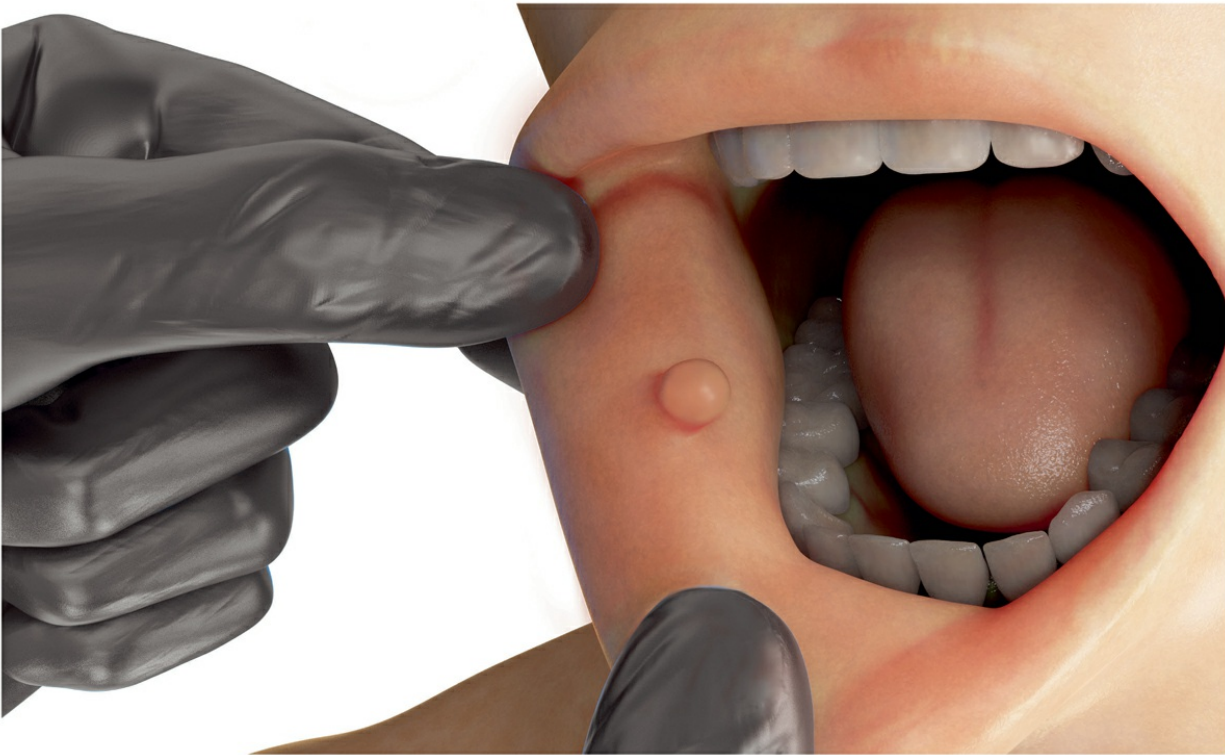


Fig 3-13 (a) Retraction sutures may also be used for removing overgrowths caused by irritation. Retraction with a suture would facilitate the line between the tissues and the overgrowth.

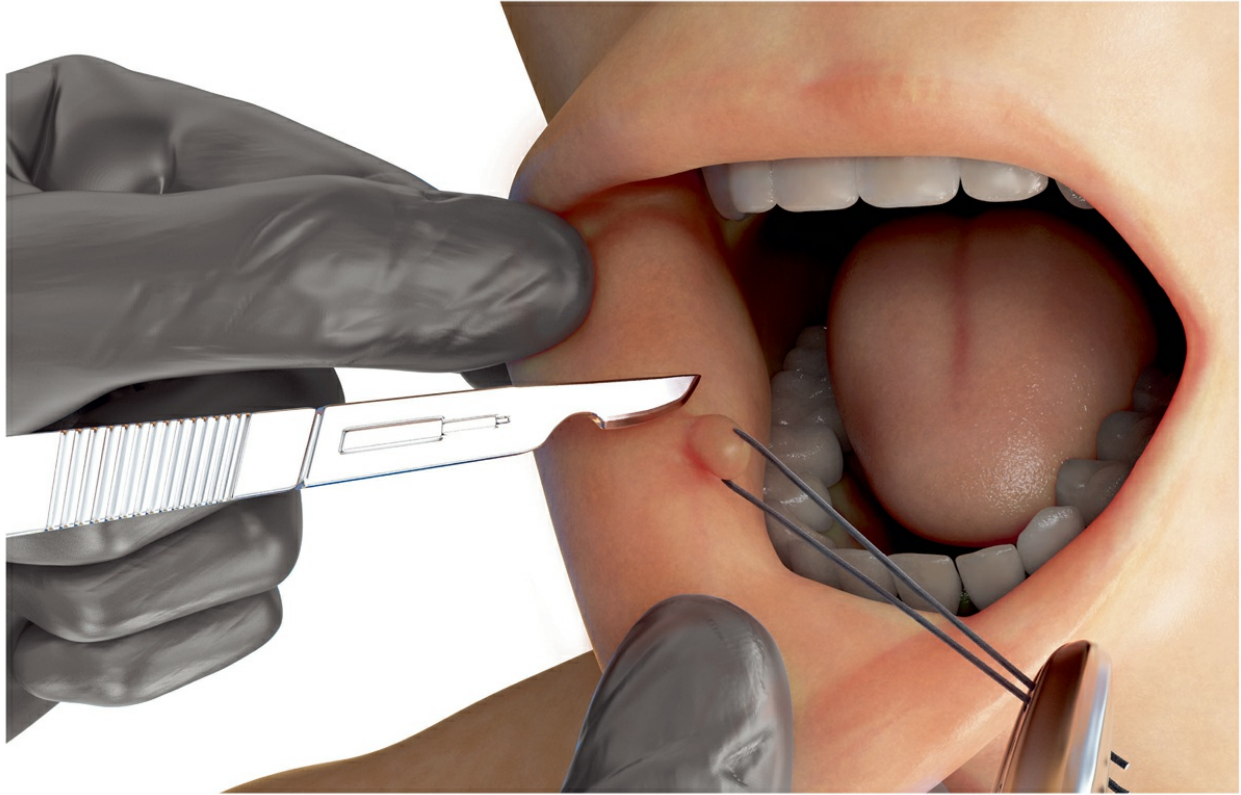


Fig 3-13 (b) Excision is then simplified by a clearer view of the working site.

FIXATION SUTURES FOR BIOMATERIALS OR GRAFTS

Basically, these sutures are modifications of mattress sutures and are used to secure a graft or biomaterial in the desired position and/or to apply constant pressure to facilitate healing. Absorbable suture threads should be used if the intention is not to remove the sutures.

Membrane fixation sutures

Areas of usage

This type of suture is mainly used to secure the barrier membrane that is placed over bone substitutes. There are some basic requirements necessary to perform an effective membrane fixation suture. Firstly,

the membrane should be fixed at the aspect of the alveolar process with a pin or screw so that a flap can be raised. This avoids the displacement that arises from the tension exerted by the suture once it is placed. However, if the suture is anchored from the palatal mucosa, a flap should not be raised on that side. Secondly, the suture should be placed on keratinized tissue at both sides of the flap. Tissue resilience or folding would be detrimental for the desired tension and stability of the membrane. Finally, since capillarity is an issue with these sutures, monofilament suture material is preferable.

Advantages

These sutures eliminate the need to use pins and screws to fix the membrane at inconvenient angles for manipulation. Since tension may be formed by the suture, strain may occur on the membrane. Depending on the manner in which the suture is performed, it is possible to avoid folding the membrane corners outward, which would result in exposure. This is extremely crucial for non-resorbable membranes; however, these sutures can also be used for resorbable membranes.

Disadvantages

The knot supporting the suture at the palatal side often becomes embedded in the tissues, complicating the removal procedure. To eliminate this problem, it is recommended to cut the ears off long.

Technique

Buccal bony surfaces are mostly convenient to secure membranes used in bone augmentation; however, the angle of access may not always be suitable at the palatal/lingual side for the application of pins or screws. Thus, after fixation of the membrane at the buccal side, and after taking necessary measures to maintain the space under the membrane, the suture is initiated at the unelevated (or intact) part of the flap at the lingual aspect of the alveolar process.

The crux of the technique for these sutures is to avoid the membrane folding while pulling it under the flap. If folding does occur, it should happen inward rather than outward. Folding of the membrane is not an issue when resorbable membranes are used, but it may lead to early exposure in non-resorbable membranes (see Fig 3-15 a and b). For this reason, the suture should engage the membrane in such a way that outward folding of the membrane and thus possible exposure is prevented. To this end, an 'out-out-in-in' flow should be followed. As this suture is basically a mattress suture, this flow works in the direction that the layers are being engaged: first the mucosa and membrane from the outer surface to the inner surface (out-out), then the membrane and palatal mucosa from the inner surface to the outer surface (in-in). Thus, if the membrane that is pulled underneath the flap were to fold, it would fold inwards, avoiding sharp corners that may cause premature dehiscence at the flap (Fig 3-14 and 3-15).

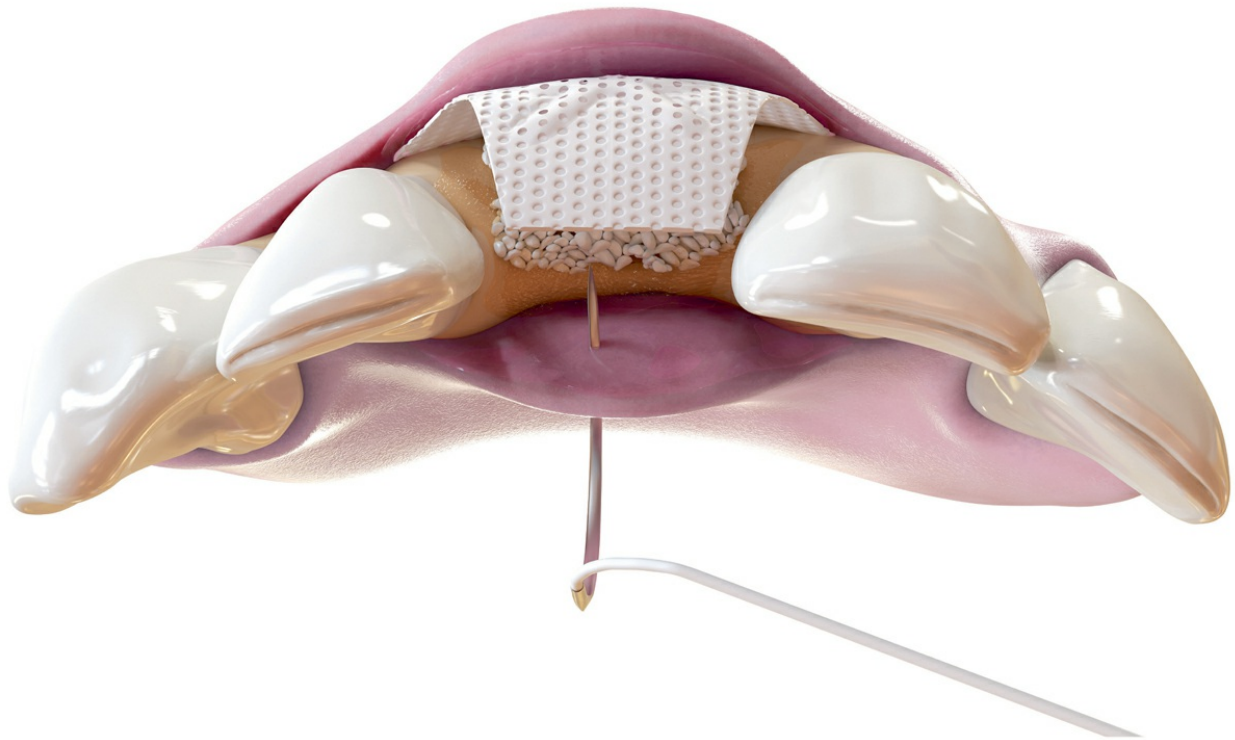


Fig 3-14 (a) The membrane fixation suture begins at the palatal side where the flap is not fully elevated. The needle is inserted through the outer surface of the flap and exits from the inner surface. It is then

Dentlearn.ir

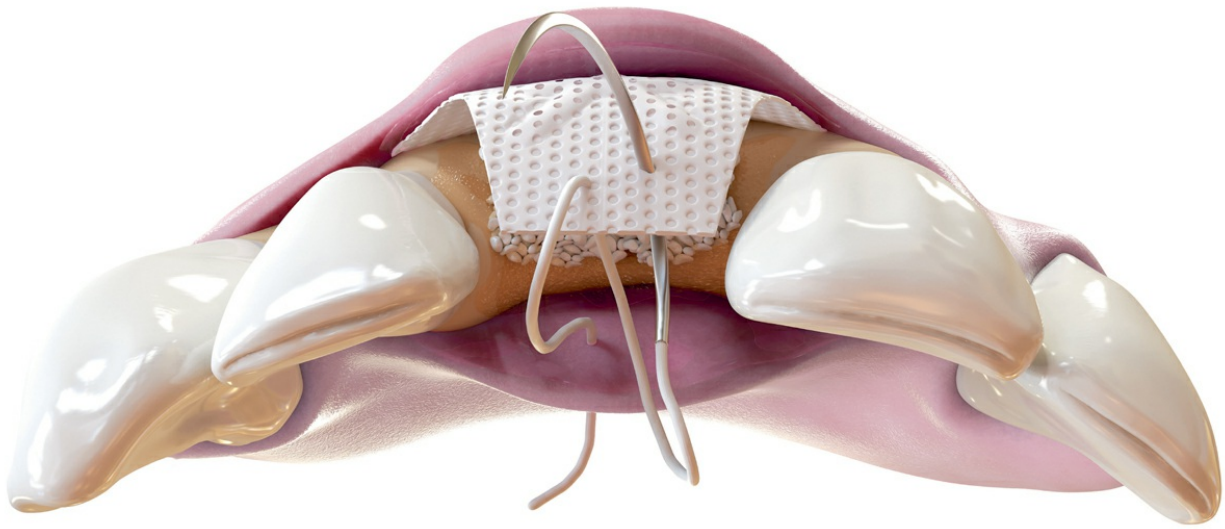


Fig 3-14 (c) The suture enters through the inner surface and exits from the outer surface of the membrane in the third step. The outer surface of the membrane is the side facing the mucosa and the inner surface is that facing the bone. This is the first 'in,' which refers to the inner surface of the membrane that is first engaged.

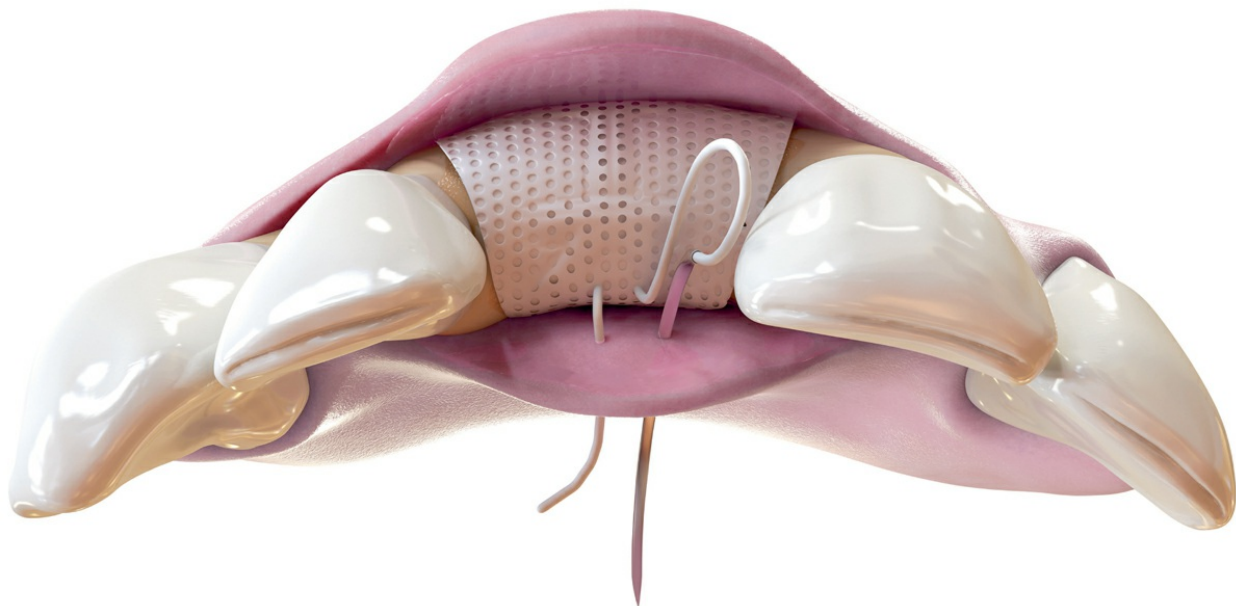


Fig 3-14 (d) The suture is then advanced under the flap at the palatal side. It enters the flap through the inner surface and exits through the outer surface near the initial point of insertion. This is the second 'in,' which refers to the inner surface of the membrane that is engaged. The suture is tied at this point and its ears are cut off long.



Fig 3-15 (a) A non-absorbable membrane was used in this patient who received regenerative treatment for peri-implantitis. An uneventful recovery was observed at the wound site at 20 days postsurgery.



Fig 3-15 (b) The same wound site at 50 days postsurgery. Folding of the membrane in an outward direction resulted in its early exposure and thus in contamination of the oral microflora to the membrane. This complication required early removal of the membrane. 'Out-out-in-in' membrane suturing prevents outward folding of the membrane that is tensioned.

Sometimes the manufacturer suggests that the engagement of the membrane may hinder the physical properties of the barrier. In such cases, membrane stability can be achieved by using the periosteum as the anchorage point (Fig 3-16).

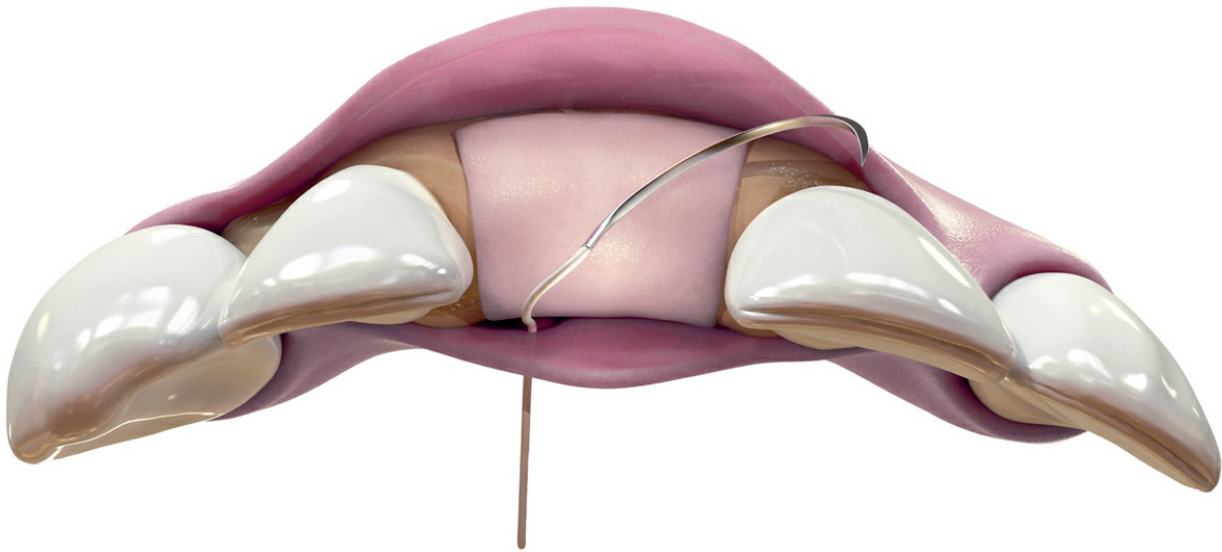


Fig 3-16 (a) Fixing the membrane on both sides of the ridge requires periosteal anchorage. The needle is first advanced through the outer surface of the palatal flap. The entry point should be located apical to the area of the membrane margin.

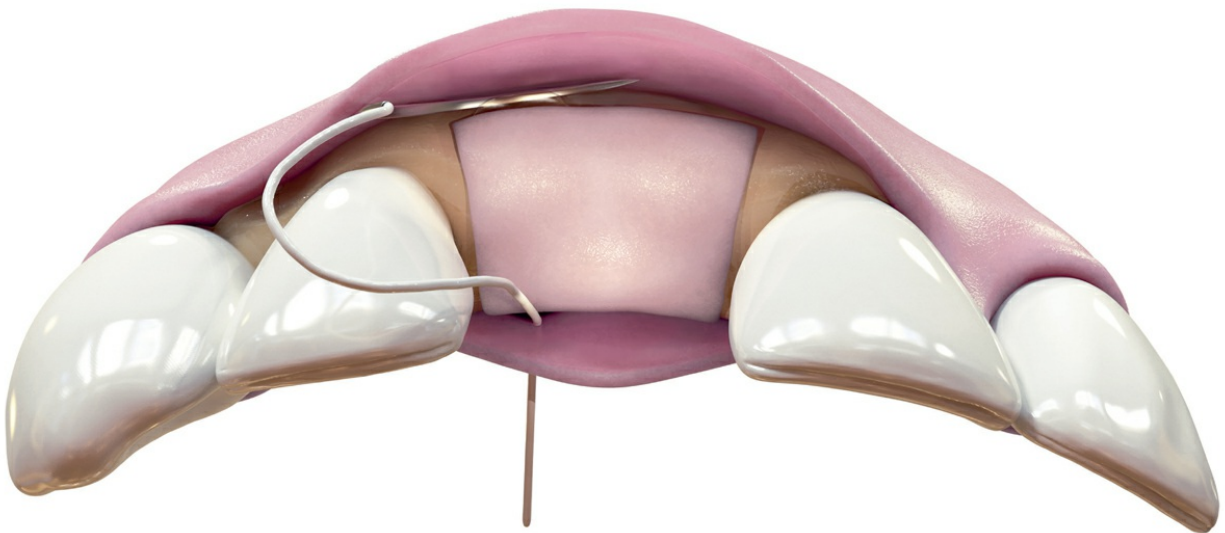


Fig 3-16 (b) At the buccal aspect, the needle is introduced under the periosteum in a horizontal direction, again apical to the membrane margin.

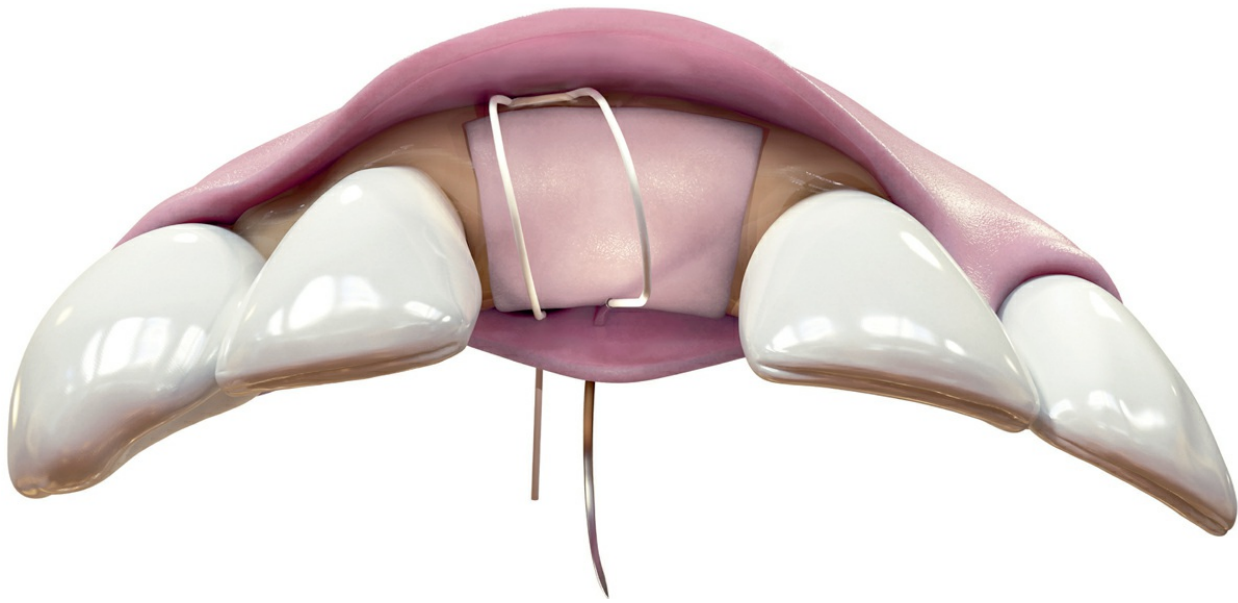


Fig 3-16 (c) With the anchorage gained from the buccal periosteum, the needle is then proceeded back to the palatal side, crossing the palatal tissue at the same level of the first entry. This allows the suture to apply pressure on the membrane, thus providing further stabilization.

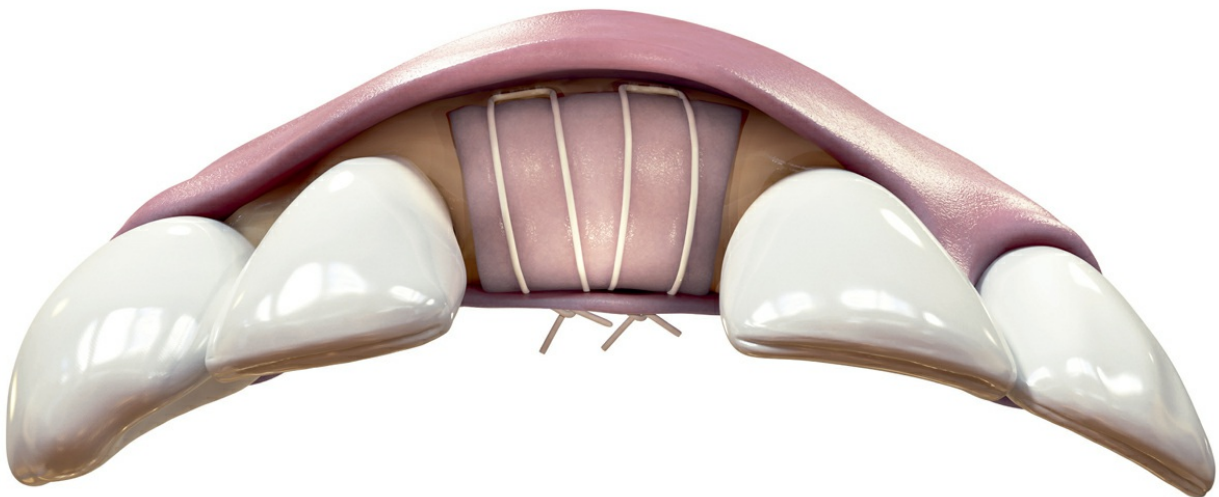


Fig 3-16 (d) The suture is tied at the palatal side. The procedure should be repeated for sites with wide membranes.

Sutures for adapting autogenous soft tissue grafts to the recipient site

Areas of usage

These sutures are used for better adaptation of connective tissue grafts or free gingival grafts to the recipient site. Monofilament threads should preferably be used when these sutures are placed between tissue layers, and multifilament threads when they are placed over the tissues. The primary function of these sutures is to secure the graft in its place, while the secondary function is to limit or avoid the dead spaces under the graft that may jeopardize graft nourishment. This type of suture also serves to protect the blood clot.

Advantages

These sutures offer good protection against unintentional trauma, limit the dead spaces under the graft, and secure the blood clot.

Disadvantages

It can be difficult to locate the thread at the time of removal in cases where it is embedded in the tissues. It is therefore recommended to cut the ears long. Another disadvantage is the possibility of over-tensioning the sutures, which can cause the periosteum to rupture. To avoid this, care should be taken at the point of periosteal engagement on the apical side. When loose submucosal tissue is used as the anchorage point on the apical side, the risk of coronal displacement is increased due to the coronal stretch of the tissues (Fig 3-17).

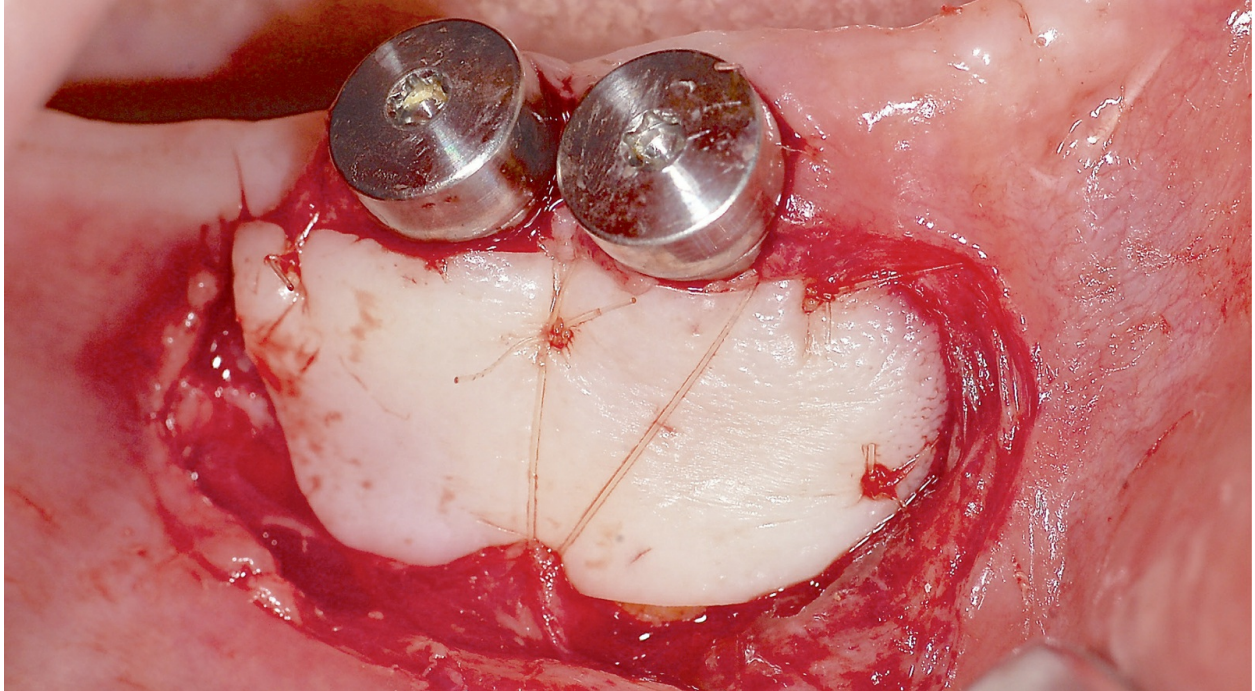


Fig 3-17 The loose connective tissue used as a point of support at the apical aspect of the suture placed to facilitate graft adaptation resulted in stretch and fold over the graft. This may result in the transfer of mucogingival mobility to the site of grafting.

Technique

For connective tissue grafts

This suture is applied for better adaptation of the graft to the periosteum by gaining support from the immobile papilla base and the periosteum apical to the margin of the graft (Fig 3-18).

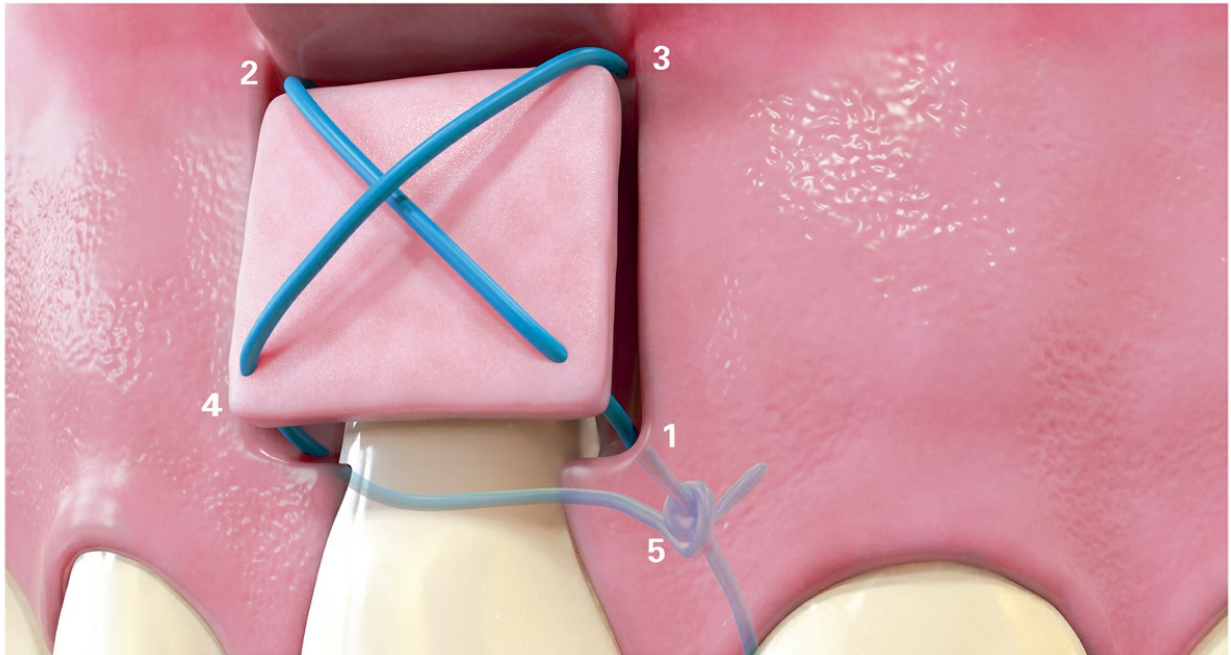


Fig 3-18 This suture, which aims at ensuring better adaptation of the connective tissue to the surface of the recipient site, begins at the lingual/palatal side [1]. The suture is initiated from the base of the lingual/palatal papilla, exiting from the recipient area at the buccal aspect, which corresponds to the base of the buccal papilla. The suture then engages the graft from the 'in' to the 'out' with respect to the position of the recipient bed. The suture advances diagonally on the graft and enters through the periosteum [2] at the apical transverse corner. It then continues to advance under the periosteum at the horizontal plane and exits the periosteum apical to the corner where the suture is initiated [3]. The graft is not included in the suture in the second and third steps, since engagement of the graft may result in folding of the tissues. The suture is once again crossed over the graft diagonally, reaching the other end of the coronal margin [4] and advancing through the graft 'out' to 'in,' and through the base of the papilla. Leaving the base of the papilla at the lingual side allows the thread to be locked with the initial lead of the suture [5]. This suture should preferably be performed with a resorbable suture thread under circumstances where suture removal is not possible. Monofilament sutures will facilitate smooth tissue passage where the tissues are delicate.

This tight but comfortable fit prevents the occurrence of dead space that may result from clot formation between the graft and the tissues, which provides ideal conditions for plasmatic circulation (Fig 3-19). A 6-0 monofilament thread should be used for this suture.

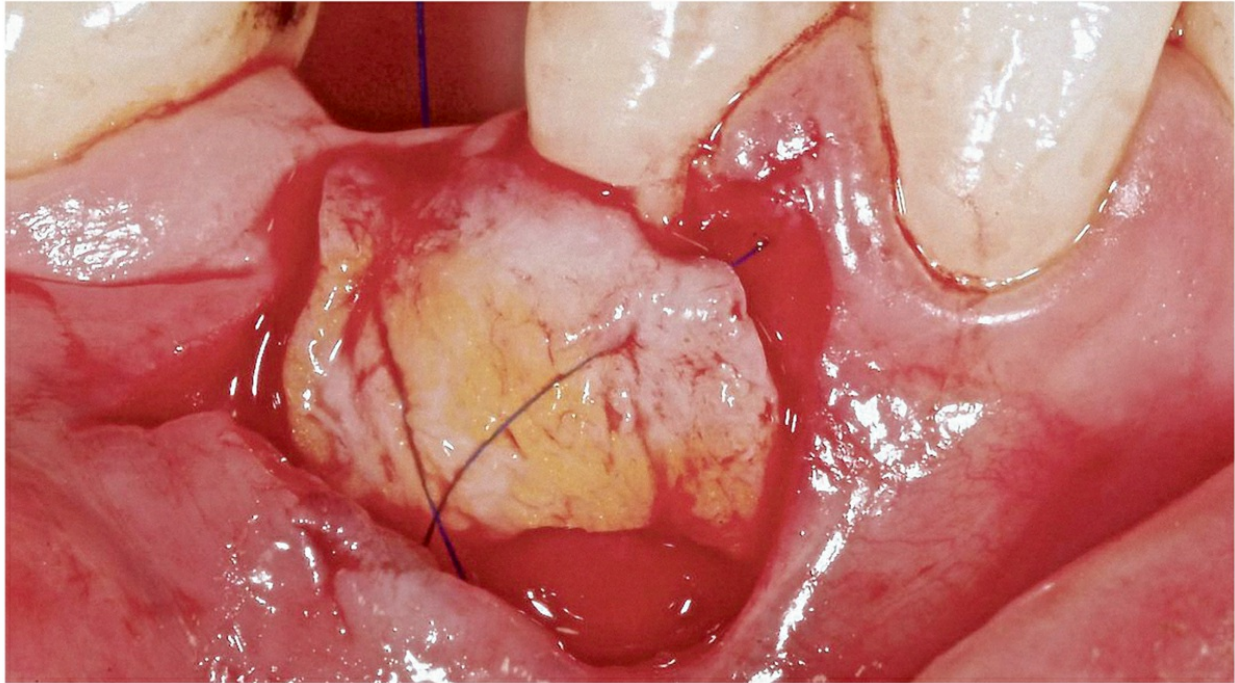


Fig 3-19 Placing an adaptation suture prevents the mobilization of the graft and the occurrence of dead space underneath the graft.

For stabilizing the clot at the donor site

When keratinized tissue for a graft is harvested from the palatal mucosa, the connective tissue is left exposed to the oral cavity and an unstable fibrin layer forms over it. This layer is vulnerable to trauma during mastication, resulting in repetitive bleeding. It is best to cover this exposed connective tissue surface with a protective material (a collagen sheet, sterile paper, a gauze, etc) and fasten this in place with a parallel or cross mattress suture (Fig 3-20) to help the blood clot to stabilize over the tissues, between the harvesting site and the protective layer.

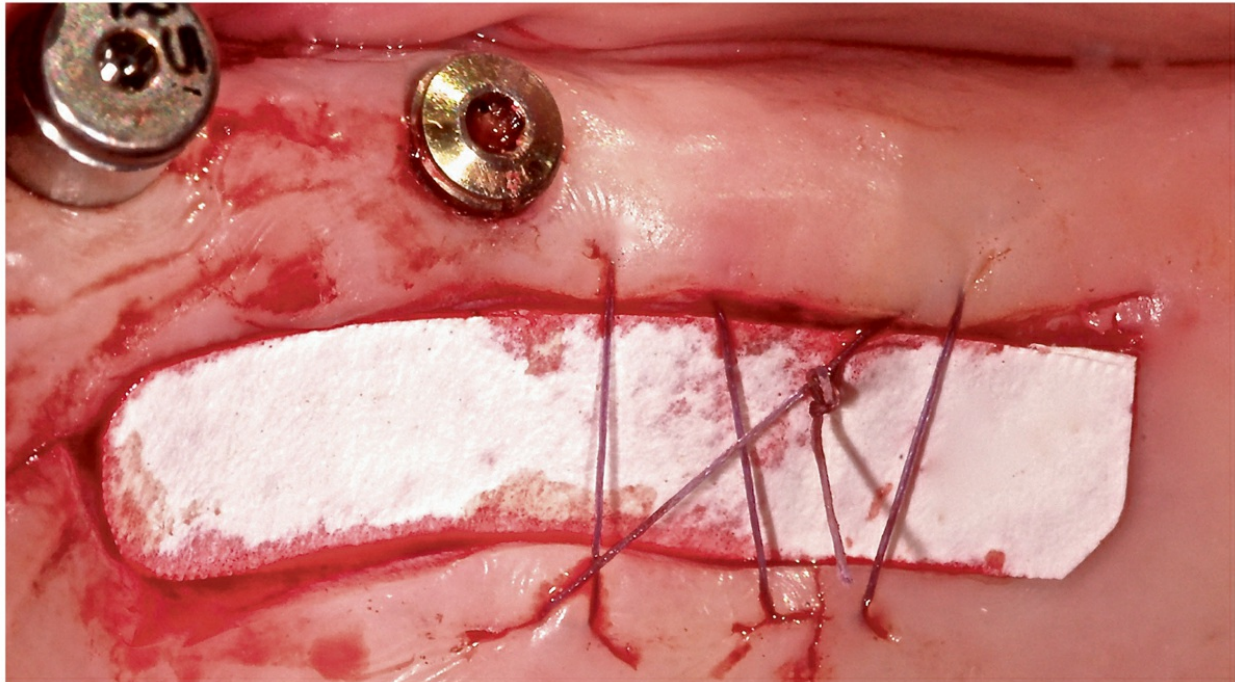


Fig 3-20 This suture is used to protect the donor site by preserving the clot on the surface of the connective tissue where the graft is harvested as well as to prevent recurring bleeding.

To improve free gingival graft adaptation

The suture is suspended around the cervical area of the teeth or implants to improve the adaptation of the graft to the recipient bed. It is tied after passing through the periosteum on the horizontal plane approximately 3 mm apical of the graft (Figs 3-21 and 3-22).

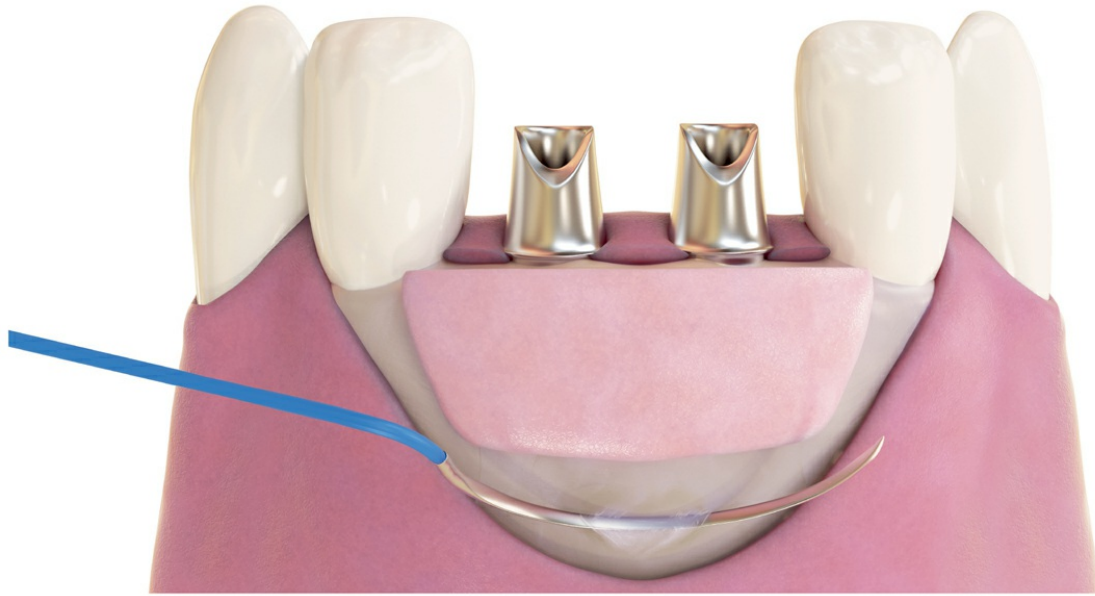


Fig 3-21 (a) A 15- to 18-mm-long needle is passed under the periosteum on the horizontal plane, 3 mm apical to the graft. A reverse cutting needle and 5-0 or 6-0 monofilament thread is a good choice to avoid the tearing of the periosteum.

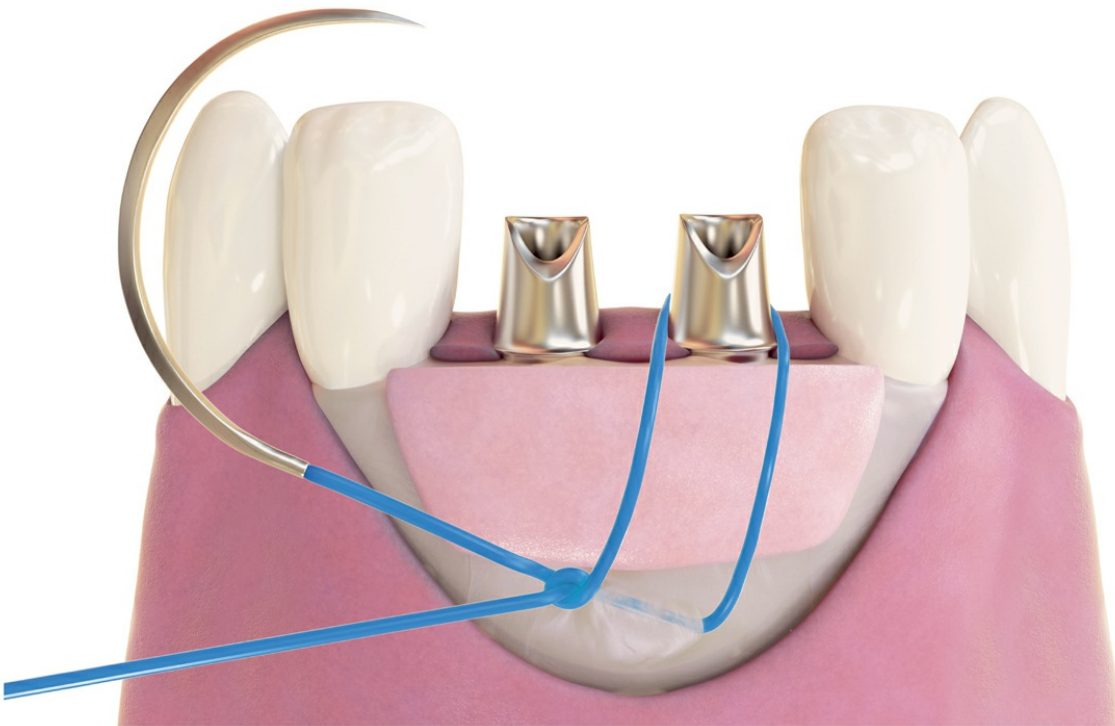


Fig 3-21 (b) This is a mattress suture, in principle. A delicate tension should be applied, sufficient to facilitate adaptation but not enough to rupture the periosteum.

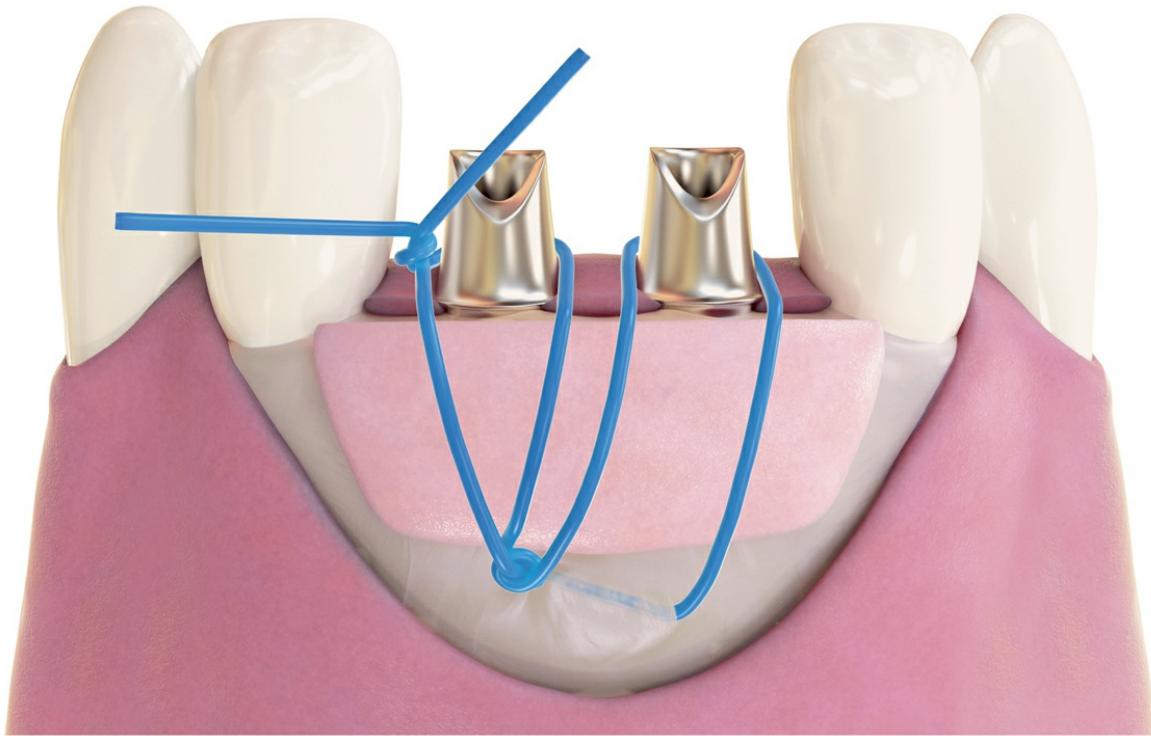


Fig 3-21 (c) For grafts that are wide enough for two teeth or implants, the suture can be modified as a continuous one, with additional anchorage from another tooth or implant. For longer grafts, however, the authors' clinical experience suggests that single sutures are preferable, since the anchorage from different periosteum sites distributes the tension on the thin tissue and reduces the risk of tearing. Stretching the periosteum or loose connective tissue and folding over the graft would mobilize the graft and adversely affect the healing process.

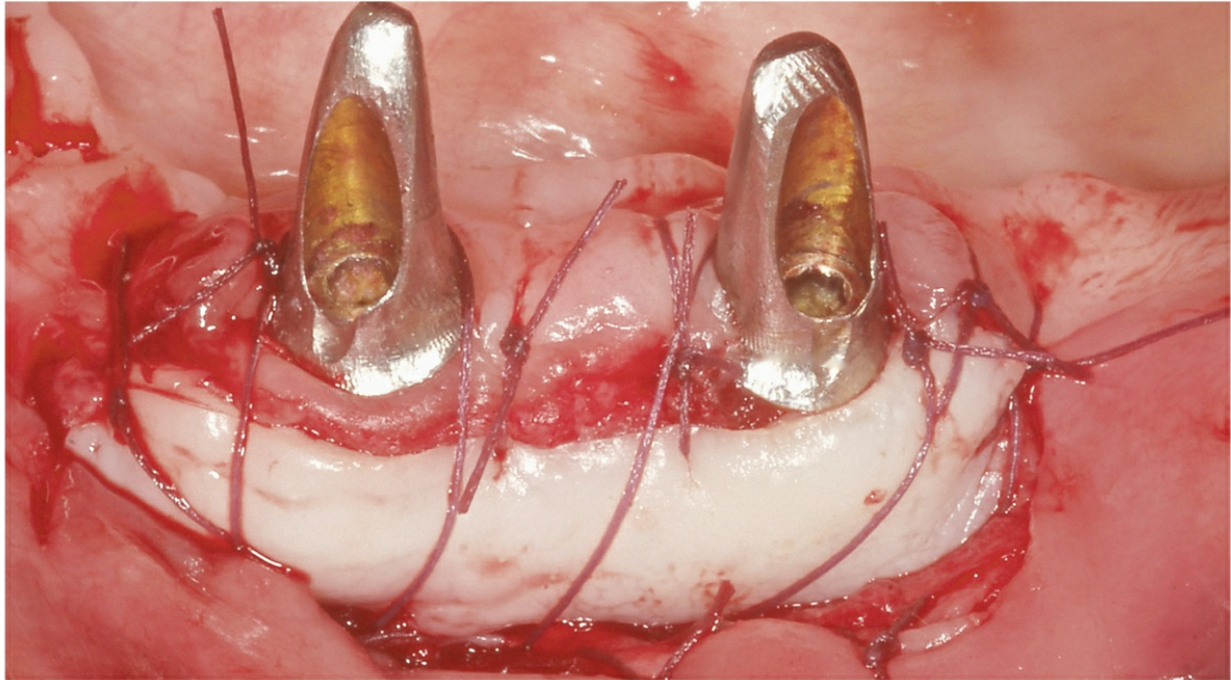


Fig 3-22 Clinical image of this very old case showing a free gingival graft and sutures placed 5 years after the completion of a prosthetic procedure due to peri-implant mucositis. After the graft is secured to the recipient site with interrupted sutures placed at the coronal side, a compression suture is placed to better rest the graft on the surface. This is done to ensure that the graft is not affected by the neighboring muscle and tissue attachments. In this case, multifilament threads were used for this purpose. However, today's practice indicates monofilament or coated multifilament threads for this type of surgery. The adaptation suture should be supported by the periosteum, and the fragile structure of the periosteum needs to be protected against additional trauma caused by the multifilament thread.

SUTURES FOR SECURING SURGICAL DRESSINGS OR PACKINGS

Areas of usage

This type of suture is used to fix a surgical gauze at a desired position, either for stabilizing a clot or for the constant application of pressure. It

is used in patients receiving anticoagulant agents with anticipated postoperative bleeding, for those not capable of performing oral hygiene procedures to protect the site, and in special cases requiring stabilization of clotting in extraction sockets. It can also be used for sinus perforations smaller than 2 to 3 mm after extraction, where the sinus membrane heals uneventfully. The main goal is to stabilize and preserve the clotting.

Advantages

Effectively prevents potential postoperative complications.

Disadvantages

Requires technical precision. Impairs healing when misplaced in the socket.

Technique

The gauze to be secured must be damp and free of thread remnants that may cause discomfort for the patient. The suture is used to avoid displacement into the anatomical socket and can either be performed in a single-stage or a two-stage procedure, depending on the site of use. However, it should be borne in mind that dry gauze may adhere to and damage the clot when it moves. The standard practice is to place the suture in the orifice of entrance of the extraction socket. If there is a risk of dropping the protector into the deep tissue, the suture (which is basically a mattress suture) should be placed on the top and bottom of the protector. If no such displacement is anticipated, a single top suture will suffice (Fig 3-23). A modification of this technique can also be used in open wounds to control bleeding and facilitate healing (Fig 3-24).

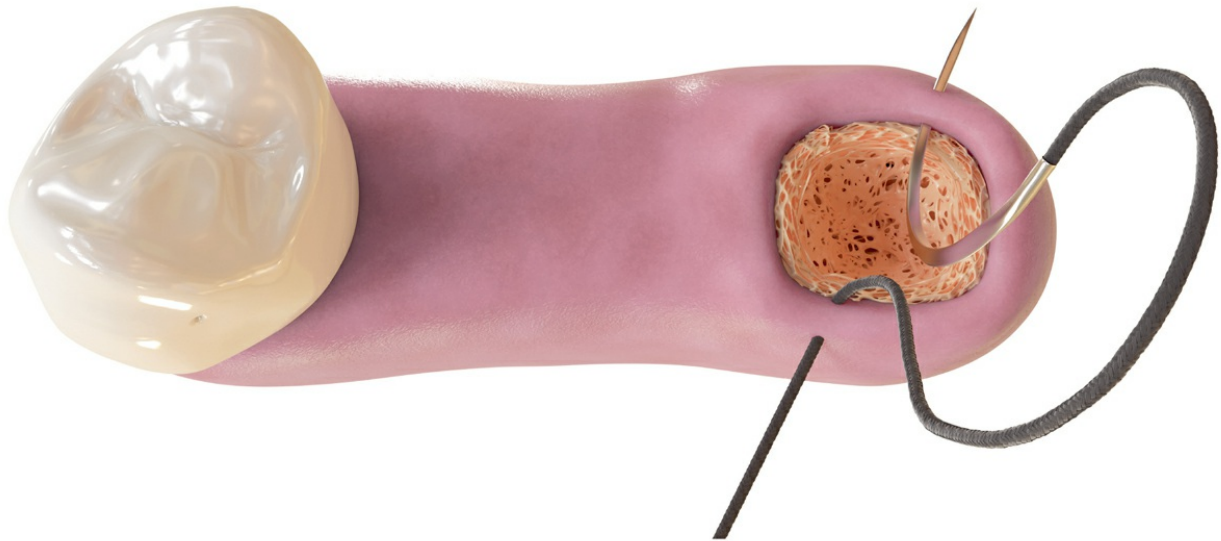


Fig 3-23 (a) The suture is initiated at the attached gingiva of the extraction socket. To improve stability, the remaining gingival margin is engaged in such a way that the attached gingiva is also included in the bite. The suture, crossing the orifice of the extraction socket, first advances through 'out' to 'in' on one side, and then through 'in' to 'out' at the opposite corner.

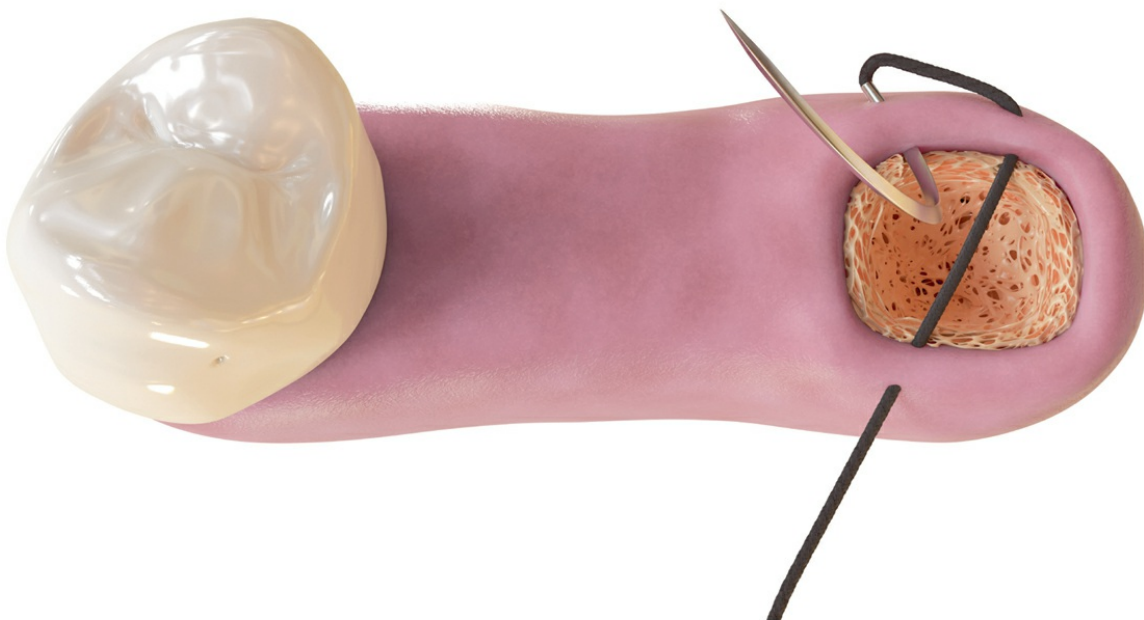


Fig 3-23 (b) Securing a dressing or gauze on a wound requires anchorage from the wound margins. The needle is then introduced through the gingiva in the direction from 'out' to 'in' on the same side of the socket.

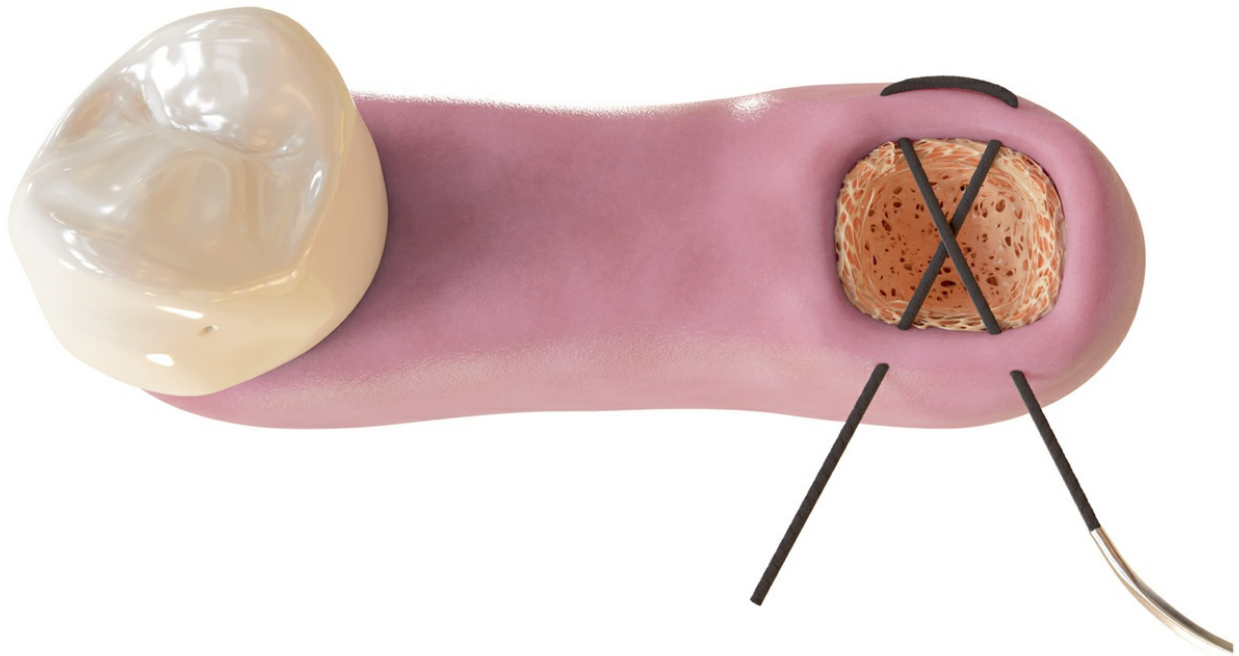


Fig 3-23 (c) The suture is once again placed across the orifice of the socket, engaging the gingiva in the direction of 'in' to 'out' and forming the mattress suture. This first crossing suture will ensure that the packing will not be displaced into the socket.



Fig 3-23 (d) Both ends of the suture are tied to approximate tissue margins, contracting the wound area. This prevents clot mobility in deep-rooted teeth with larger extraction sockets. It also protects the clot against external factors by forming a barrier.

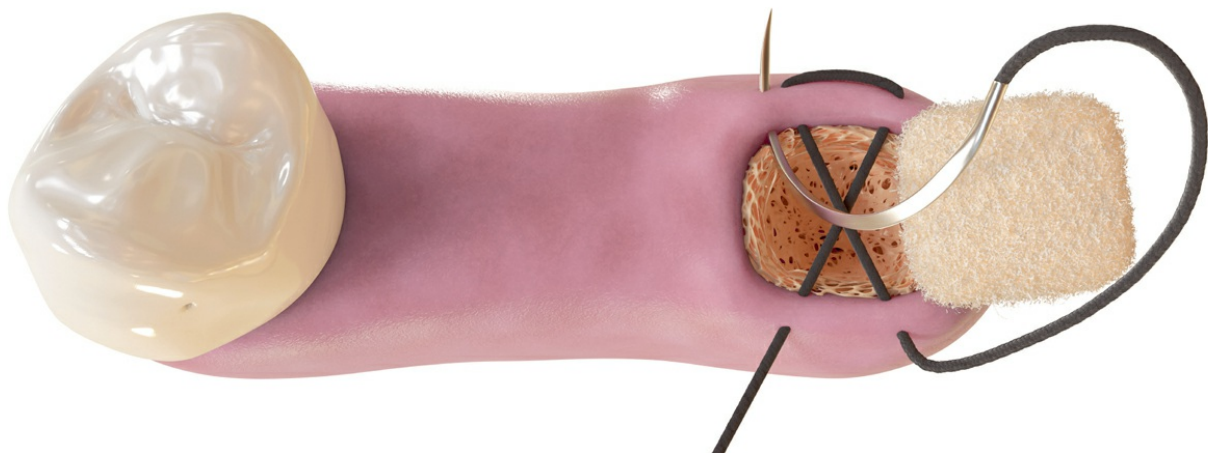


Fig 3-23 (e) Ensuring and maintaining clot stability are essential in cases such as maxillary sinus perforation or to control bleeding. For this reason, the suture is not terminated with a knot; instead, this is used as the anti-displacement part, and another mattress suture is performed. The first suture will prevent displacement of the gauze into the socket. A damp gauze slightly larger than the extraction socket is placed on the first cross mattress suture, and another suture is made through the gauze.



Fig 3-23 (f) The gauze is secured between two cross mattress sutures. It is crucial to dampen the gauze be-cause if it is dry it will absorb all the blood inside the socket and lead to an impairment of the healing process.

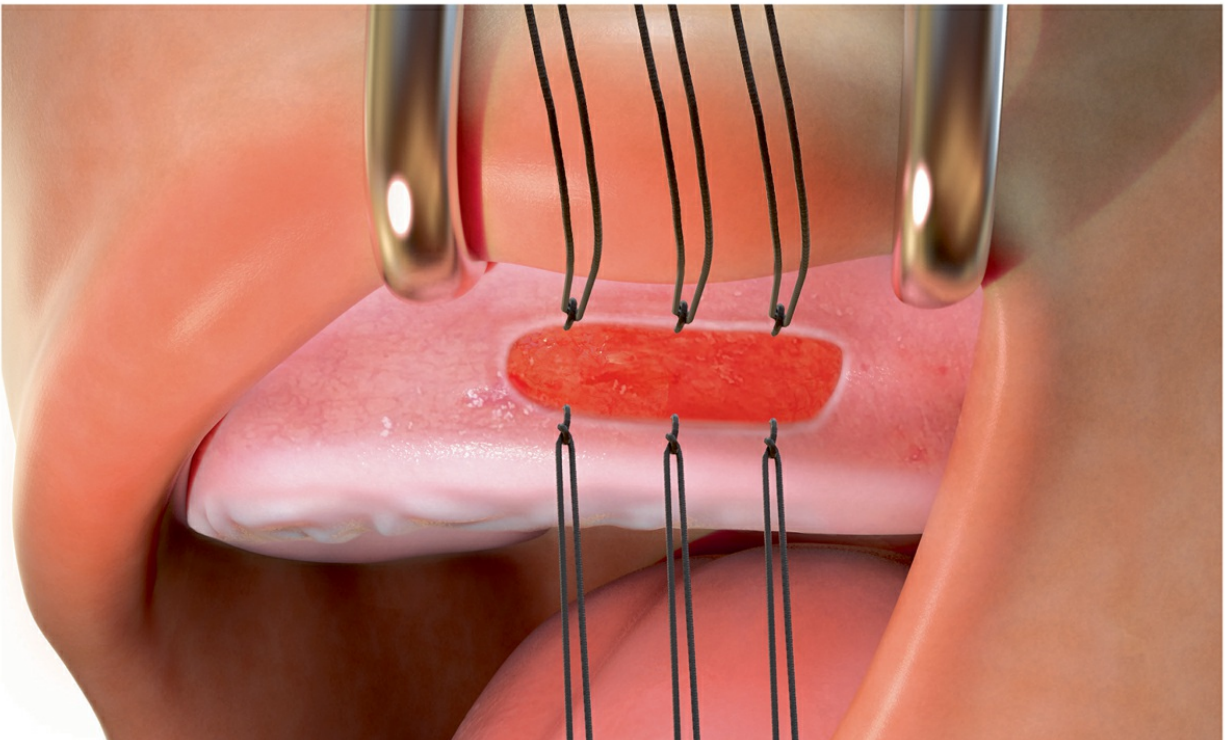


Fig 3-24 (a) The same technique can be used to fix and stabilize the tissues when providing external support for the forced displacement of tissues. In such cases, simple sutures are placed on the wound at the

desired frequency and distribution. The ears are left long enough to provide length for the tie at the next step.

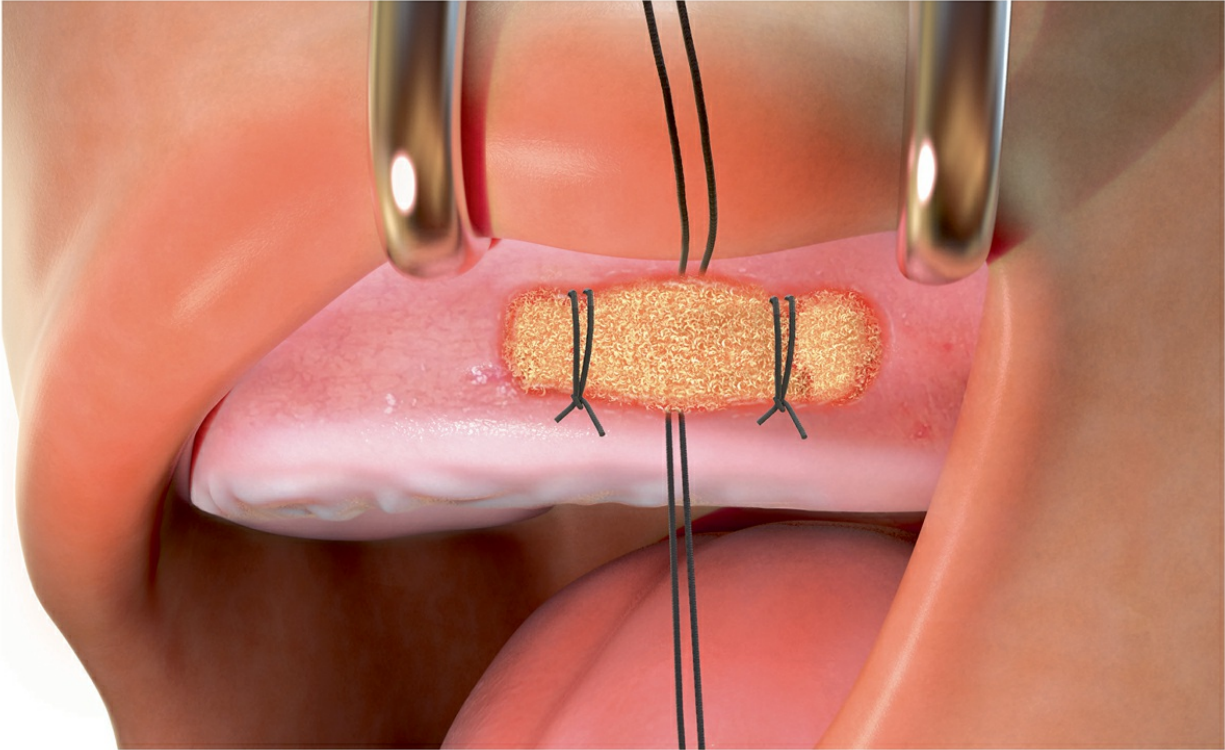


Fig 3-24 (b) The gauze is then placed over the simple sutures and secured with the second tie over.



Fig 3-24 (c) The purpose of the gauze, which should be wet, is to apply hemostatic pressure and prevent the mobilization of the soft tissue to the wound site.

HEMOSTATIC SUTURES

Areas of usage

These sutures are not used to approximate dissected blood vessel edges to suture them together; instead, they aim to contract the lumen by compressing the peripheral tissue. They are used to control or prevent bleeding from an artery or vein during graft harvesting from the palate, or when a pedunculated mass is removed and expected to bleed.

Advantages

Bleeding control is essential to maintain a better view of the working site and for patient comfort. When bleeding is anticipated for

anatomical reasons or due to the nature of the mass, a preventive suture may be placed.

Disadvantages

Although there are no real disadvantages of this suture, the removal time must be carefully calculated since the prolonged presence of this suture, especially at the palate, would lead to ischemia.

Technique

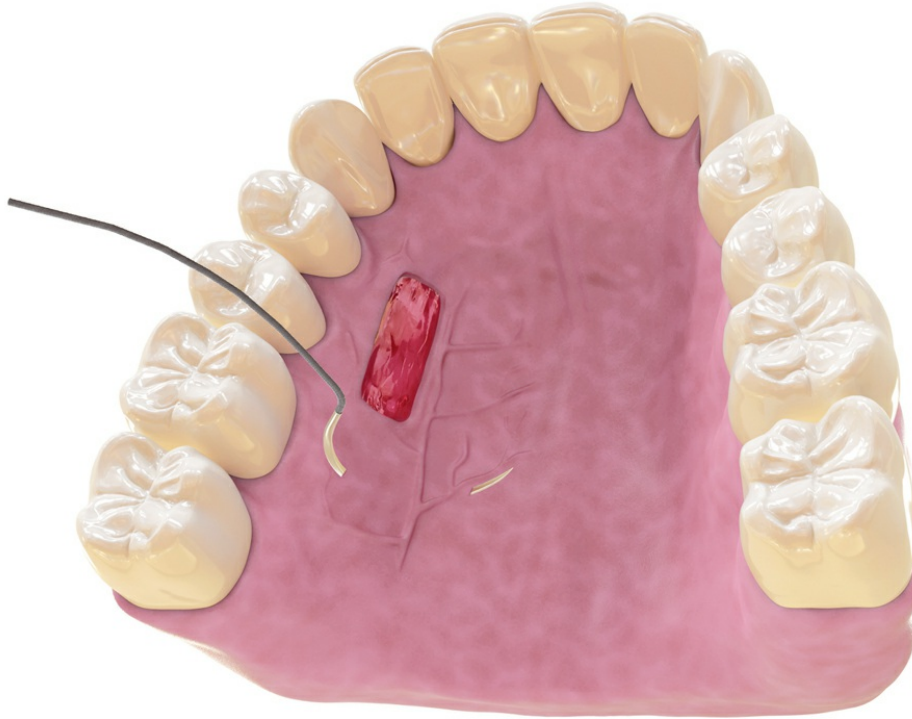
For greater palatine artery bleeding

These are not permanent sutures and should be removed once their purpose has been achieved. It is best to use multifilament thread to perform this suture because its primary function is to prevent loosening of the initial knot.

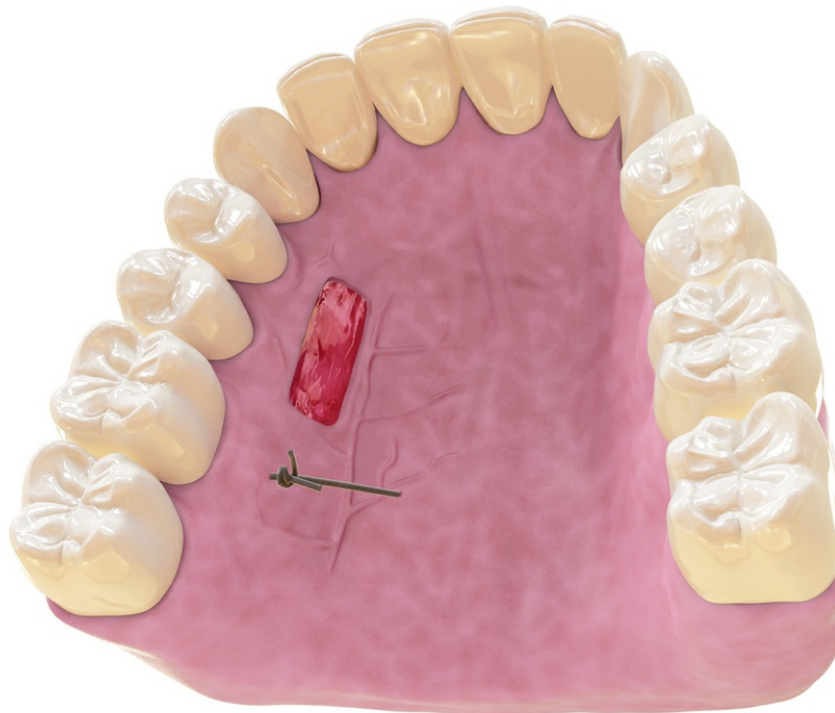
Using a relatively thicker 3-0 multifilament thread would help the initial knot and facilitate the procedure by putting pressure on the peripheral tissue over the vessel. It is recommended to use a 15-mm-long 1/2 circle needle for this type of suture.

The suture should be placed at the right location in the procedural field; in such cases, between bleeding and the possible anatomic course of the vessel. This location can be decided by applying pressure with a blunt instrument to the possible course of the artery. At a certain point, the pulsative bleeding will become oozing, thus indicating the pressure on the vessel.

Placing the suture to loop around the artery would apply pressure to the tissues surrounding the vessel, narrowing its lumen. In such cases, if the first suture does not help to control the bleeding, others should be placed. The removal of hemostatic sutures once the grafting procedure has been completed and the wound has closed usually allows the site to heal more quickly (Fig 3-25).



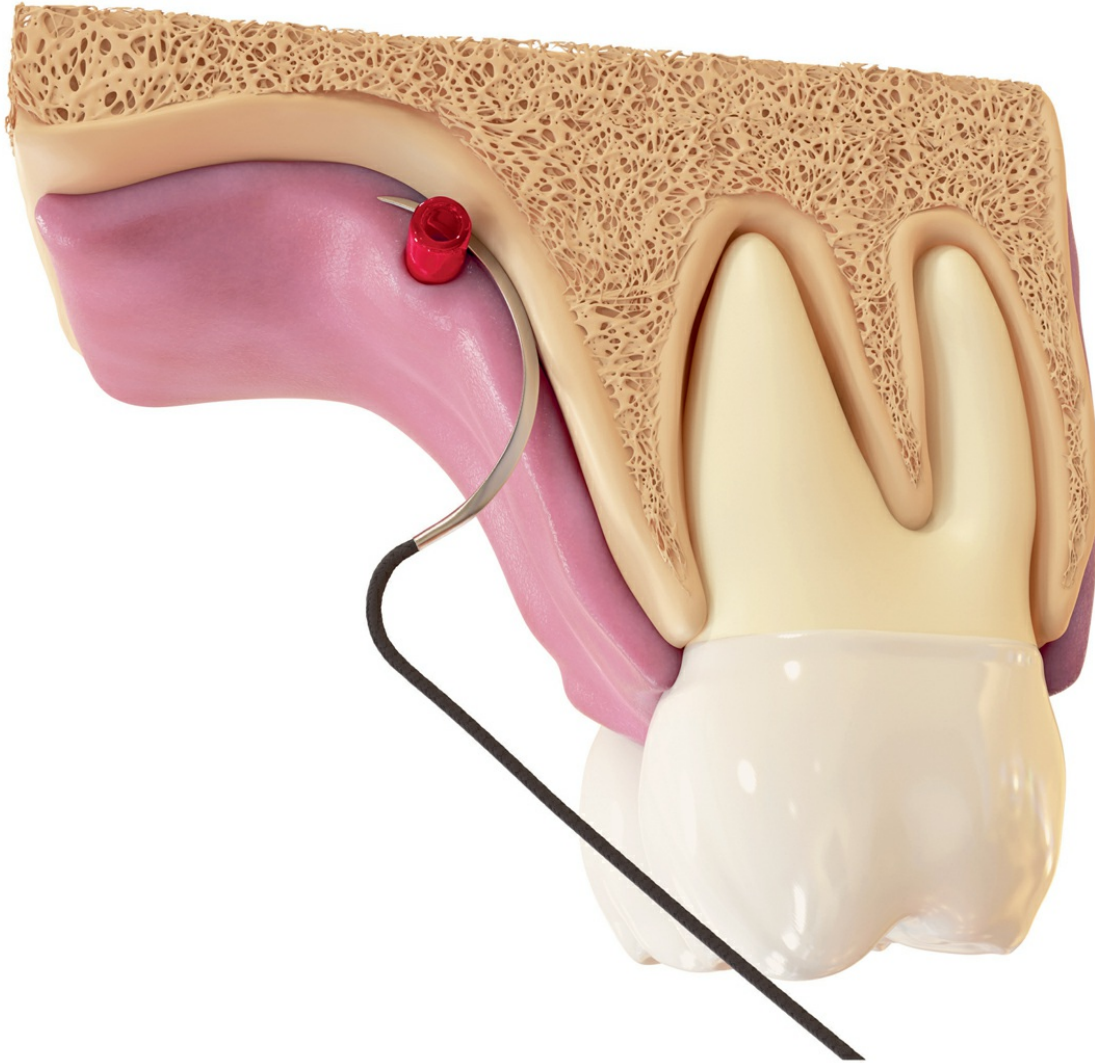
a



b

Fig 3-25 (a and b) The needle is inserted as deeply as possible to the extent allowed by the tissues at an area close to the point of

emergence of the blood vessel that supplies the bleeding site from the bone. The intention is to narrow the dimensions of the lumen of the blood vessel with pressure applied by the neighboring tissues. Multifilament threads with high knot-holding security should be used for this type of suture.



C

Fig 3-25 (c) The needle is inserted as deeply as possible at the first bite so that it advances under the blood vessel, parallel to the osseous contour. At some suturing locations, the palatal mucosa can be 5- to 7-mm thick at the conjecturable trace of the artery. It is therefore advisable to practice the maneuver in advance.

Another version of this suture can be used for the removal of pedunculated masses that have bleeding potential. Prior to the removal of such a mass, the peduncle should be constricted with the suture loop, impairing the blood supply of the mass and thus securing its uneventful removal.

POSITIONING SUTURES

These sutures are used to position grafts, membranes, and flaps through the tissue layers. (Note that for the purposes of this description, the term 'grafts' is used to mean all these types of structures.) For practical reasons, the surgeon should be certain of the final location of the graft, since these sutures begin at the final point of the graft to be placed. The suture travels through the tissue layers. After engaging the graft, the needle returns to its original point of insertion through the same course and meets with the end that was left at the beginning. Pulling both ends of the positioning suture introduces the graft through the path that the suture has travelled.

Since the suture must travel in between the tissue layers, a monofilament suture thread is recommended due to its high gliding properties. Furthermore, it is preferable for the suture to break than for the tissues to tear. For this reason, the thread chosen for this purpose should have lower strength properties than the tissues to be carried.

Areas of usage

These sutures are used in the surgical treatment of gingival recession performed by the tunneling technique, displacing connective tissue pedicle flaps from palatal to vestibular, and routing tissues and grafts through other tissues.

Advantages

The length of these sutures is flexible, provided that the bed or graft tissues are not engaged, i.e. if the suture engages any soft or hard tissue in the course of travel, it will not be able to pull the graft to the

desired position. Positioning sutures placed on opposing ends of the graft in tunnel surgery allow the graft to be stabilized at the desired position.

Disadvantages

It is difficult to travel this type of suture through the tissue layers at the same level, and it is common for the suture to catch or shift to another layer. Furthermore, it is not possible to move the graft if this happens. Under these circumstances, it is always better to start from the beginning rather than to force the suture through the tissues.

Technique

The final position of the graft should be well known prior to the procedure. Positioning sutures should begin at points outside the margins of the graft so that the graft can be displaced to the desired location, i.e. if the starting point of the suture is within the area to which the graft is being advanced, it will not be possible to pull the graft all the way to the desired location. Positioning sutures should not become obstructed by tissue layers and should not transverse different levels of tissues because the tissues that are being pulled into position will become trapped and stick inside the tunnel through which the suture has advanced (Fig 3-26).



Fig 3-26 (a) When it is advanced under the tissues, special care should be exercised to ensure that the needle remains on the layer where the graft is to be advanced and does not pierce through the tissues. The needle should therefore be inserted with its sharp point facing rearward and its eye facing forward in order to avoid tissue rupture or puncture.

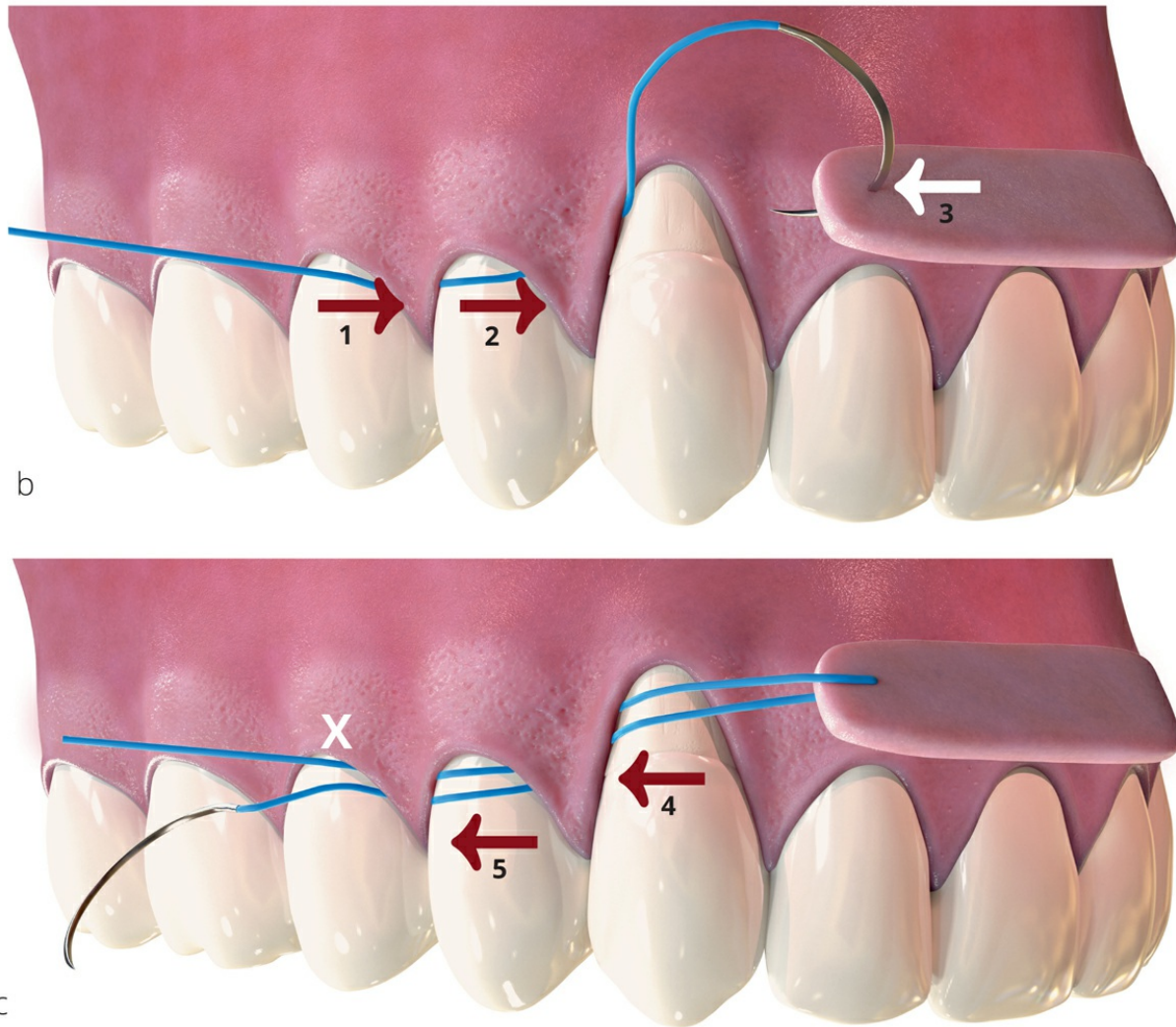


Fig 3-26 (b and c) The needle and thread are advanced under the tissues inside the tunnel [1,2] until they meet the graft tissue to be displaced [3]. The suture passes through the graft once or twice, depending on the physical properties of the tissues, then returns to its original position following the same route [4,5], meeting the other end of the thread at the original point of entry to the tunnel [X]. Both ends of the suture are then pulled to advance the graft into the tunnel and place it in the desired position.

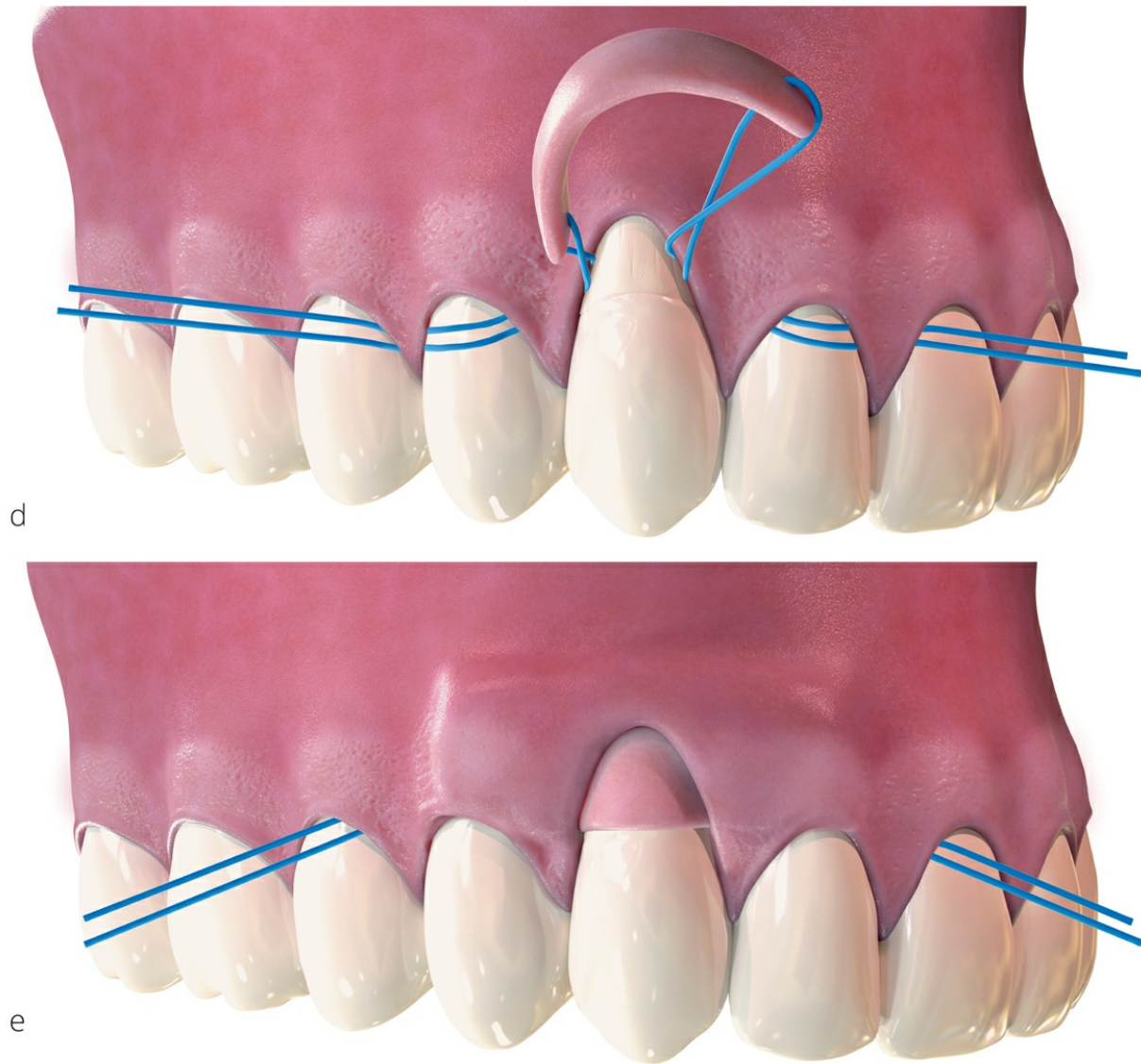


Fig 3-26 (d and e) When a connective tissue graft is to be positioned for recession coverage, the same procedure should then be applied for each individual end of the graft, and positioning sutures should be pulled in both directions to adjust the final location of the graft.

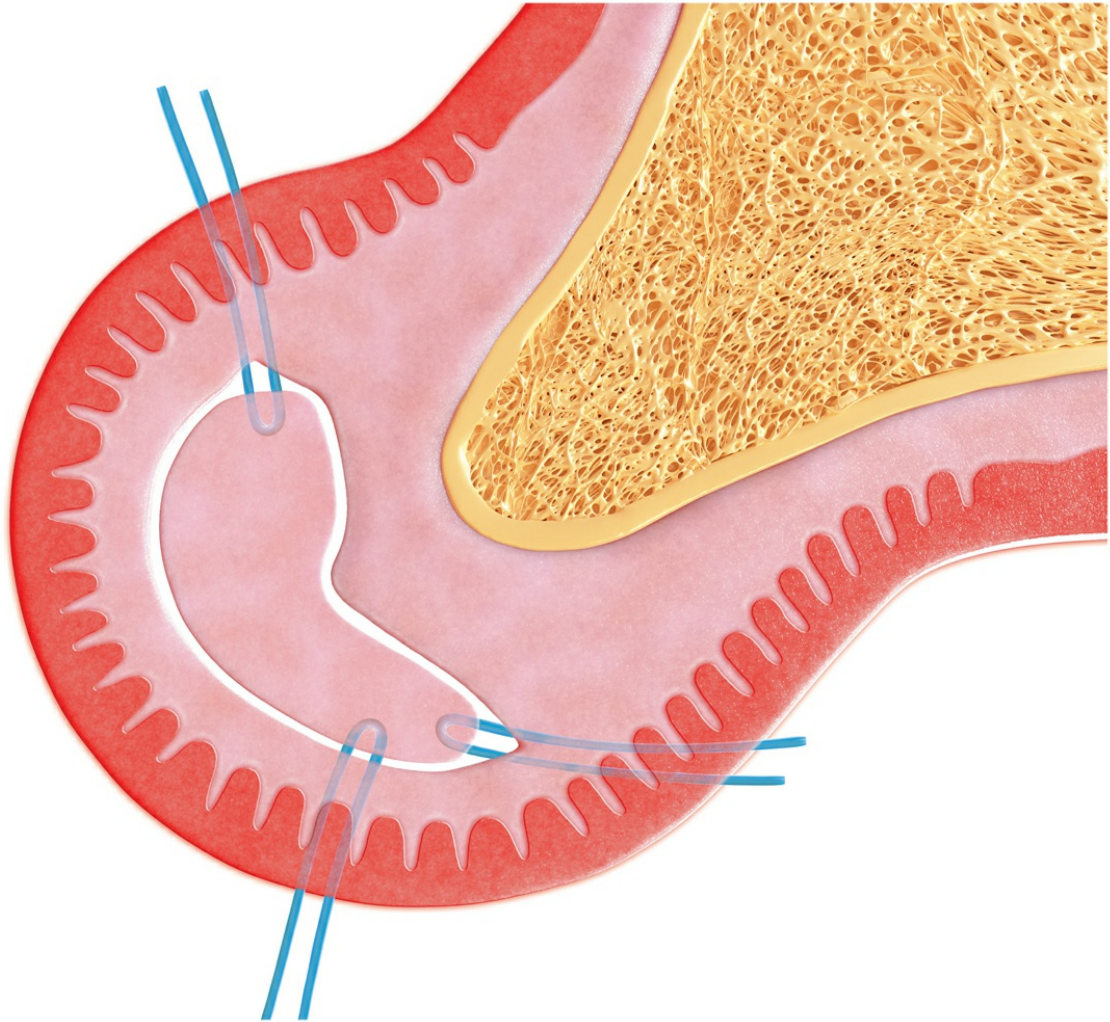


Fig 3-26 (f) This basic principle can be modified to obtain numerous positionings, e.g. it is possible to use several positioning sutures to steer the graft in more than one plane to place it on the crest.

It is recommended to use monofilament threads for these sutures. Since multifilament threads do not have a smooth tissue passage and do not glide, they may become trapped by the tissues. Prolonged surgery time results in even poorer tissue passage due to blood clotting on the surface.

SUTURES TO PREVENT FOREIGN MATERIAL FROM TRAVELING INTO DEEP TISSUE

Areas of usage

These sutures are primarily used prior to or during the surgical removal of a sialolith, impacted teeth or a fractured root fragment.

Advantages

These sutures limit the movement of hard tissue particles, preventing them from falling into deeper tissues or sockets. This facilitates the surgery, saves time, and avoids potential complications.

Disadvantages

It is relatively easy to place this type of suture at the distal of the sialolith; however, sutures to be placed for fragmented root fragments require high technical precision.

Technique

After locating the sialolith in the salivary gland duct, a suture is placed at the distal of the structure to prevent its mobilization by the forces to be applied during the surgery (Fig 3-27).



Fig 3-27 (a) Sialoliths that are small in size do not completely block the canal, hence limit the full discharge of the saliva through the canal. This causes swelling, which can be seen at the right of this image.

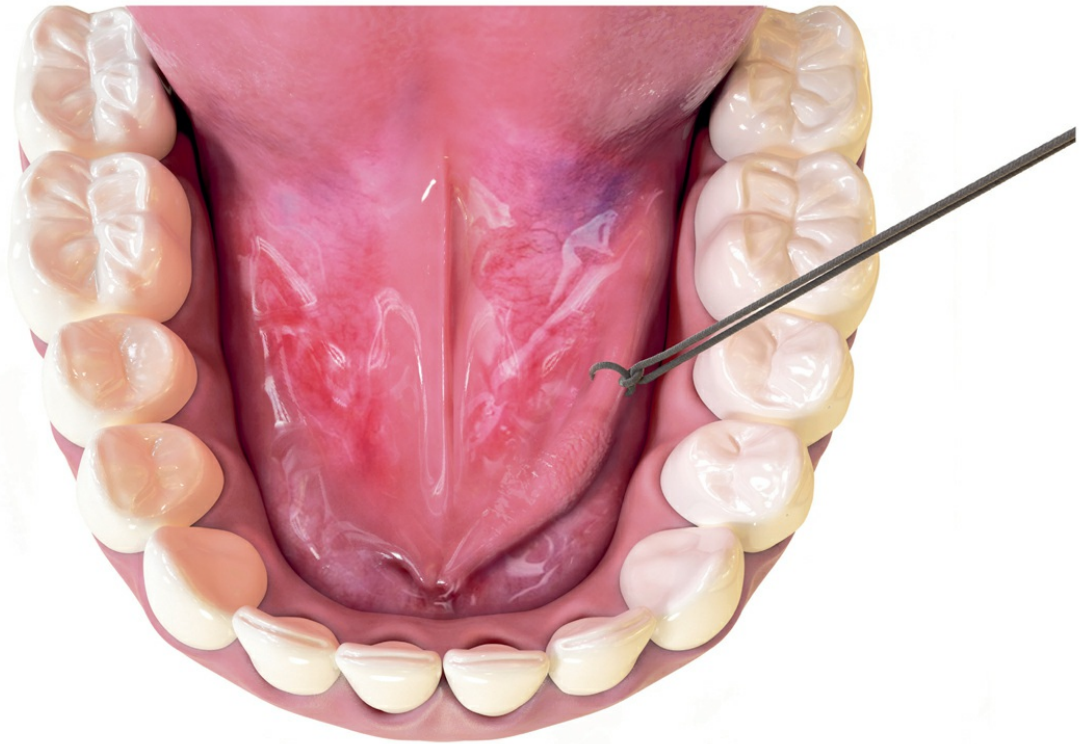


Fig 3-27 (b) Prior to the surgical procedure, a single suture is placed immediately posterior to the area where the sialolith is suspected to be located.

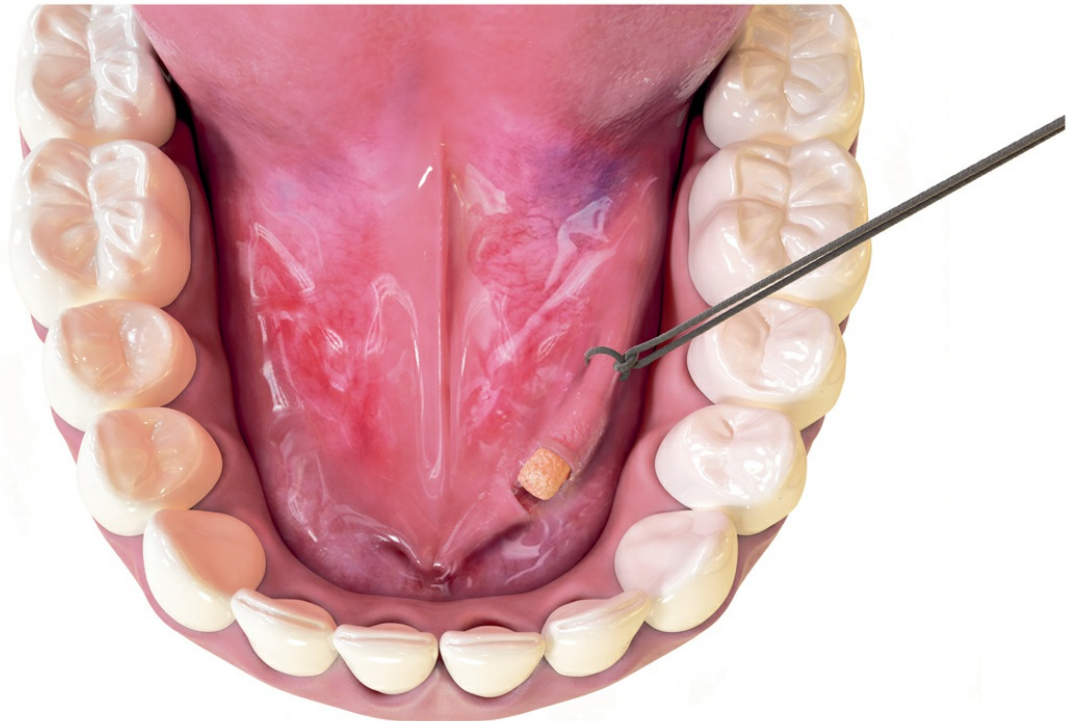


Fig 3-27 (c) The sialolith, which is already very slippery with saliva, is prevented from dislocating into deeper tissue layers further down the canal during the procedure.

In impacted third molar surgery, where an entire tooth or a root fragment has accidentally moved into the anatomical space, a suture is placed at the distal, inferior or superior side of it (depending on its current position) to prevent it from traveling further down into deeper layers.

ABSCCESS DRAINAGE SUTURES

The main function of these sutures is to maintain the communication of the abscess with the outer surface. Braided sutures are thus recommended.

Areas of usage

This suture can be used during abscess drainage in all extraoral abscesses. It is preferable to use it in cases where scalpel incision scars are to be avoided.

Advantages

Although the lines for extraoral abscess drainage need to be aligned to the facial lines, scar buildup may still result after healing. Performing drainage using only a suture instead of a scalpel may result in a scar that is far less significant than a scalpel scar.

Disadvantages

With sutures, abscess drainage is slower than with incisions and requires the sutures to be moved slightly on a daily basis to ensure that drainage is maintained and clogging is prevented.

Technique

It is recommended to use the thickest available suture thread and make two interrupted sutures, passing through the deep tissue at an exact 90-degree angle. The distance between the sutures will depend on the size of the abscess. The knots are tied far away from the wound edges, leaving long ears. The patient should be invited for wound dressing every day, and the suture threads should be moved back and forth and up and down the abscess to drain it through the groove between the thread and the tissues (Fig 3-28).

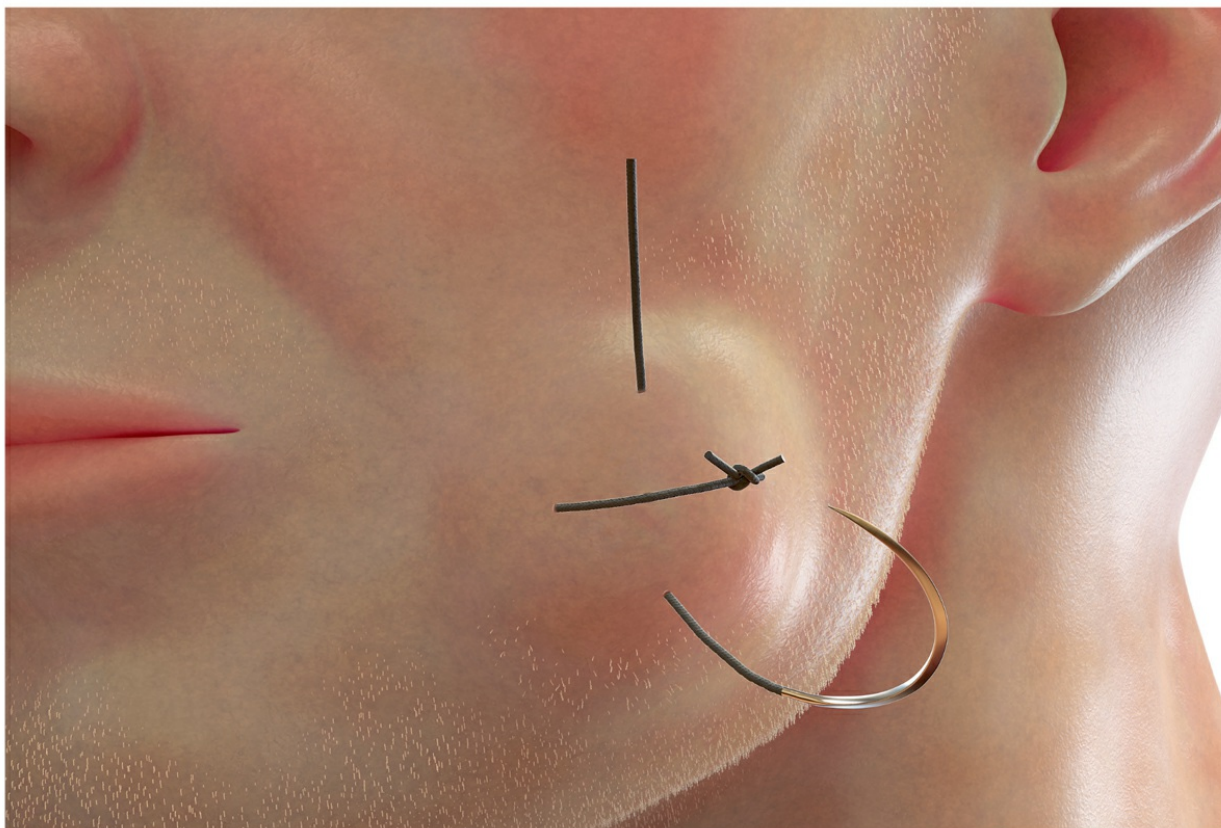


Fig 3-28 (a) Thick suture threads (1-0 or 2-0) should be used to perform abscess drainage smoothly. Two interrupted sutures should be placed on the abscess at an angle of 90 degrees to each other.

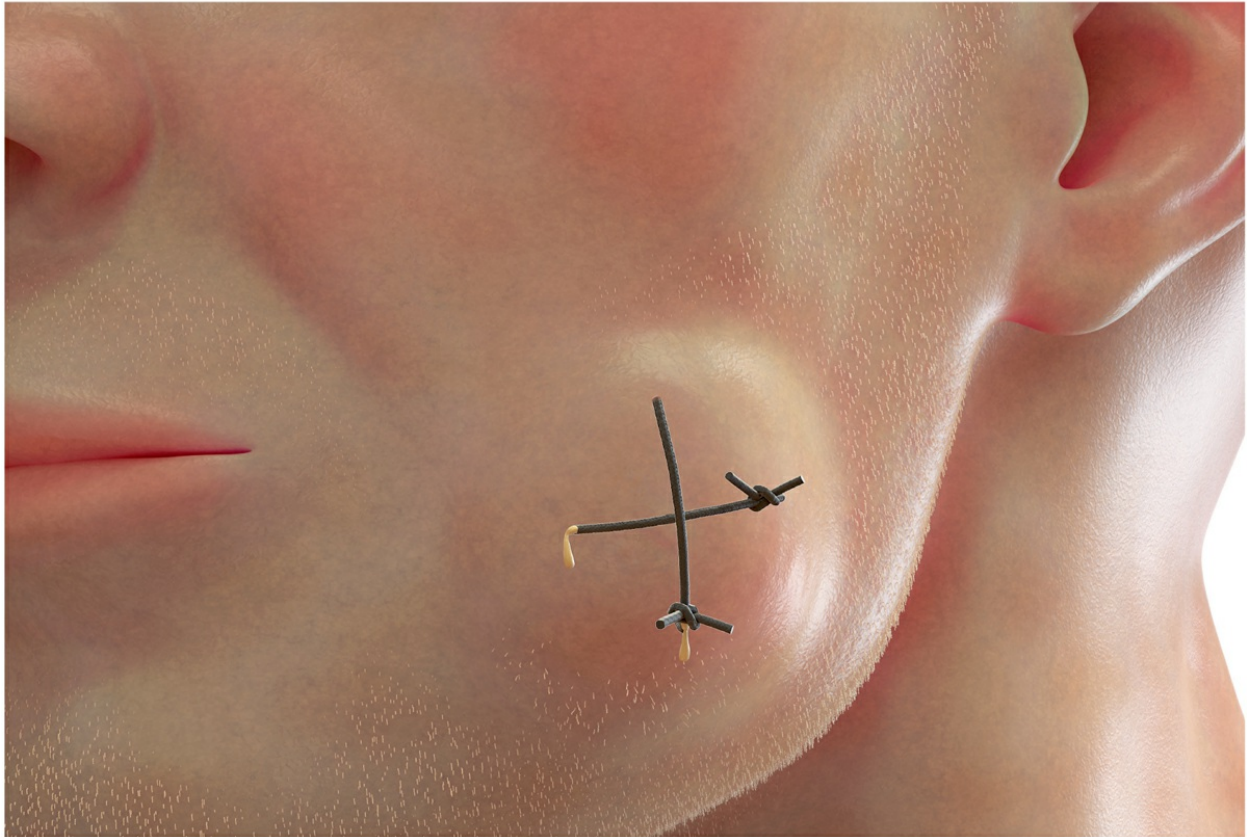


Fig 3-28 (b) The suture threads should be moved back and forth and up and down on each other during wound dressing to drain the abscess through the groove formed by the threads.

Recommended reading

1. Brandt MT, Jenkins WS. Suturing principles for the dentoalveolar surgeon. Dent Clin North Am 2012;56;281–303.
2. Burkhardt R, Lang NP. Fundamental principles in periodontal plastic surgery and mucosal augmentation – a narrative review. J Clin Periodontal 2014;41(suppl 1):S98–S107.
3. on Periodontology. Surgical techniques on periodontal plastic of the 10th European Workshop on Periodontology. J Clin Periodontal 2014;41(suppl 15):S92–S97.

4. Sentineri R, Lombardi T, Berton F, Stacchi C. Laurell-Gottlow suture modified by Sentineri for tight closure of a wound with a single line of sutures. *Br J Oral Maxillofac Surg* 2016;54:e18–e19.
5. Servo S. *Suturing Techniques in Oral Surgery*. Quintessence, 2008.
6. Zuhr O, Akakpo DL, Hürzeler M. Wound closure and wound healing. Suture techniques in contemporary periodontal and implant surgery: interactions, requirements, and practical considerations. *Quintessence Int* 2017;647–660.