Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Baghdad
College of Dentistry

Gingival retraction techniques and materials

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Conservative Dentistry in Partial Fulfillment for the Bachelor of Dental Surgery
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2022 A.D. 1443 A.H.

Certification of the Supervisor

I certify that this project entitled "**Gingival retraction techniques and materials**" was prepared by the fifth-year student **Kawther Ali Adnan** under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor Degree in Dentistry.

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ACKNOWLEDGMENT

First and foremost, I would like to express most gratitude to **Allah** for giving me the strength, endurance and patience to achieve this project.

I would like to express my deepest respect and gratitude to the Dean of College of Dentistry, University of Baghdad **Dr. Raghad AbdulRazzak Al- Hashimi.**

My sincere gratitude and heartfelt thanks to my supervisor **Dr. Mohamed Talal,** for his spiring personality and for being supportive, advisable, and encouraging continuously in all scientific as well as moral levels.

Special thanks to **Assist. Prof. Dr. Anas Falah,** Head of the conservative department and all other seniors and lecturers for high ethics and for standing help.

Dedication

I dedicate this project to:

My great parents, who never stop giving of themselves in countless Ways,

My friends, who stand by me when things look bleak,

My supervisor, who has been a constant source of support and Encouragement

And to all people in my life who touched my heart.

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Introduction

Gingival retraction can be explained as the procedure of deflecting the marginal gingiva away from a tooth. Accurate recording of finish line is a very important parameter for fabrication and successful prognosis of restorations. The position of finish lines, periodontal health, and sulcus hemorrhage during impression production all influence the quality of the impression. Exposure of sub- gingival finish line, with adequate moisture control to capture the finish line details in impression, is the main goal of gingival retraction procedure **(Krishna *et al*., 2013)**.

In fixed prosthodontics; the aim of gingival retraction is to allow the impression material to go beyond the abutment margins and to generate enough room for the impression material to be thick enough. The thickness of the impression material can have an impact on its tear resistance **(Wassell *et al*., 2002).** To expose the prepared tooth surfaces, gingival retraction should be required prior to impression. There are more voids, ripping of impression materials, and a drop in marginal accuracy in impressions with a smaller sulcular width **(Donovan and Chee, 2004).** Gingival retraction is also necessary to allow for the completion of tooth preparation or the cementation of laboratory made restorations retraction **(Ayo-Yusuf *et al*., 2005)**.

A good and appropriate retraction of the gingival tissue is necessary for a better outcome of the fixed dental prosthesis in terms of periodontal health, aesthetics, and prosthesis longevity. The appropriate installation of a fixed dental prosthesis over a prepared tooth necessitates tight contact with the neighboring tissue, namely the gingiva, therefore adequate isolation and retraction of the soft tissue around the prepared tooth is required. Gingival retraction can be accomplished using a variety of ways and materials. Thus, a number of studies have been done on the various materials and methods used for gingival retraction. **(Smith, 2007).**

Chapter one

Review of literature

1.1 History

Previously, retraction was accomplished via a variety of methods, such as the use of (cuprum ferrule). Retraction cords began to gain popularity in following years. **Harrison (1961)** experimented with different cords in a histology research on dogs. He utilized a cord that was plain, a cord that had been treated with zinc chloride and epinephrine, and a cord that had been soaked in 100 percent alum. The cords containing zinc chloride at concentrations of 8% and 40% produced extreme tissue destruction, but the other materials simply caused reversible injury. In the treatment of moderate bleeding, both 8% epinephrine and 100% alum were successful.

In dogs, Woychesin discovered that zinc chloride causes intolerable tissue damage. Ramadan used plain cord, 1/1000 epinephrine, 100 percent alum, and hemodent to measure the period of time the sulcus remained open and the width of the sulcus **(Ramadan *et al*., 1972).** In comparison to the plain string, he realized that the treated strings were more effective. **De Gennaro *et al***., on the other hand, tested the histological responses of humans to plain cord and cord impregnated with potassium sulfate, hemodent, and 8% racemic epinephrine, and found no practical difference between the cords. In addition to precipitation of tissue proteins with tissue constriction, decreased transcapillary motions of plasma proteins, and subsequent arrest of capillary bleeding, aluminum sulfate causes hemostasis through a modest vasoconstrictor effect. When administered properly, the medication is considered safe and has no systemic side effects **(De Gennaro *et al*., 1982).**

According to a survey in 1985, 95% of North American dentists utilized gingival retraction cords on a regular basis. On the US market, there were roughly 125 gingival retraction cords in various shapes, sizes, and drugs, with an extra number of variants

supplied solely in Europe **(Donovan *et al.*, 1985).** The sheer number of commercial devices demonstrated the lack of rigorous testing of gingival retraction cords' clinical performance. A novel series of knitted and twined gingival retraction cords (Gingi-Pak, Camarillo, Calif.) with dl-epinephrine or aluminum sulfate was launched in 1994. Gingival retraction cords were first commercially available in the United States. The manufacturer sent several examples of retraction cords to the Dental Faculty in Oslo, Norway, for clinical evaluation before they were released in Europe **(Jokstad, 1999).**

1.2 Gingival retraction and periodontal health

Any restoration must have a good, harmonious relationship with the periodontium in order to be successful. A precise impression is important in demonstrating such relation **(Padbury Jr *et al*., 2003).** The management of cervical lesions and enhancing the quality of impressions before to fabricating indirect restorations with subgingival margins requires the accessibility of the gingival sulcus without harming the periodontal tissue and management of the bleeding. Incomplete marginal detail in the impression causes poor marginal fit, which is the most common reason of cast restoration errors (**Ferrari *et al.*, 1996) (Hansen *et al*., 1999).**

The critical sulcular width appears to have around 0.2 mm at the finish line for there to have enough material thickness at the margins of impressions to tolerate tearing or a deformation when the impression is pulled out **(Laufer *et al.*, 1994).**

1.2.1 Assessment of biological width

The natural distance (combine heights) between the base of the healthy gingival sulcus OR epithelial attachment to the tooth and the level of the alveolar bone or connective tissue is referred to as biological width. The majority of dentists are aware of biological width, how to maintain it, and how important it is while performing crown restorations **(Majzoub *et al*., 2014).**

The value of biologic width is that it acts as a natural barrier or shield, preventing pathogens from penetrating the periodontium, ultimately determine the survival and longevity of the dental elements **(Ingber, 1977).**

1 mm of supra-crestal connective tissue attachment, 1 mm of junctional epithelium, and 1 mm of gingival sulcus make up 3 mm biological width.

Even when the restoration borders are set 0.5 mm within the sulcular depth this allows for enough biologic width **(Rosenberg *et al*., 1999).**

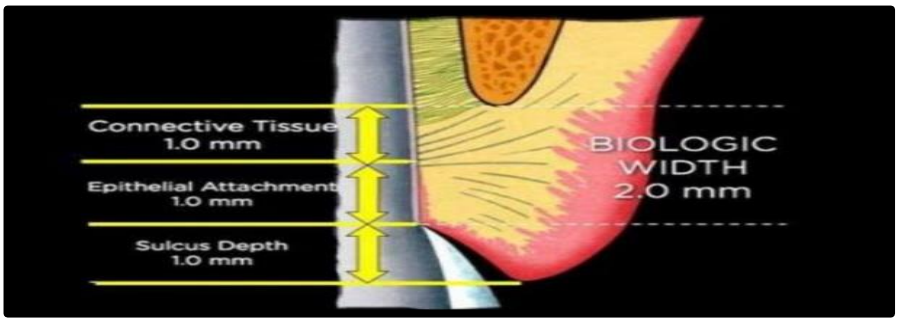

Figure 1-1. Biologic width **(Chee and Mordohai, 2010).**

1.2.2 Pre-retraction assessment of gingival tissues

Prior to any gingival retraction, an examination and assessment of gingival tissues should be considered first, and preferably when any sub gingival margins is designed, it is critical to thoroughly examine the gingival tissues and supporting structures. This is necessary because the placement of sub gingival margins, as well as the procedures used to record them, can harm the gingiva. Any forceful retraction procedure may further injure the tissues if they are already compromised **(RUEL *et al*., 1980) (SORENSEN *et al.*, 1991).** Forces act in four directions on the gingival tissues (Figure 2) when a gingival retraction procedure is used. The retraction, displacement, collapse, and relapsing forces are the four types of forces.

1. Retraction is the downward and outward pressure that is applied to the soft tissue by the retraction technique or the retraction material **(Livaditis, 1998)**;

2. Displacement is the downward force due to increased pressure exerted during retraction of the soft tissue **(Livaditis, 1998)**;

3. Relapse is the tendency of the gingival tissue to go back to its original position **(Livaditis, 1998)**;

4. Collapse is when the gingival tissues is when the gingival tissues are far more pushed towards the tooth **(Livaditis, 1998).**

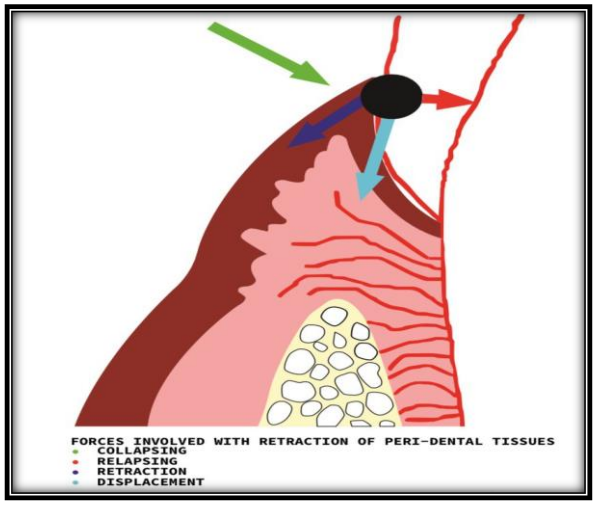

Figure 1-2. Forces involved with retraction of peri-dental tissues **(Livaditis, 1998).**

1.2.2.1 Clinical assessment

The gingival tissues that will be retracted should be firm and pink in color. The gingival biotype, which is a good predictor of the gingiva's response to operational procedures and gingival displacement, should be evaluated. Gingival tissue has been described as primarily having thick or thin biotypes, although any variety of the two can be noticed clinically, and their features are stated. The gingiva and supporting tissues should be assessed regarding contour, consistency, as well as pain. Upon probing, there should be minimum or no bleeding. Bleeding denotes irritated and damaged gingiva, which can be difficult to separate and is more vulnerable to be injured during the retraction and displacement procedure. Gingival indices can be used to distinguish between normal and diseased gingiva **(Ochsenbein, 1969).**

The gingival sulcus is another significant factor to consider when determining where restoration margins should be placed. Too deep sulcus margins necessitate additional gingival tissue retraction, resulting in destruction to the supporting

structures of the tooth. If sub gingivally positioned margins need to be used, it is advocated to be 0.5-1mm below the gingival margin, especially if the probing depth is less than 1.5 mm, and to direct the apical extent of the preparation so as not to intrude on the epithelial and connective tissue attachment. Although studies have shown that sub gingival margins do not cause rapid bone loss, there can be soft tissue recession accompanied by unaesthetic display of the gingival margins **(Knoernschild and Campbell, 2000).**

1.2.2.2 Radiographic assessment

Inter proximal bone levels and crestal bone height, and also infra-bony pockets with boss loss, can all be analyzed by peri-apical and bitewing radiographs. When gingival tissue is traumatically pushed to record sub gingival edges, unsupported soft tissue with underlying inadequate bone has a higher likelihood of recession **(Baba *et al*., 2014).**

1.3 Application of gingival retraction procedures

1. Isolation of the preparation field:

This process allows the dentist to focus directly on preparing the tooth without having to worry about the gums getting in the way, it provides the dentist a clear working view of a tooth prior to making a dental impression **(Safari *et al*., 2016)**

2. Diagnosis of subgingival caries and isolation of cavity prepared close to the gingival margin:

When caries or non-carious cervical lesions are at or below the free margin of the gingiva other tissue management techniques with gingival retraction must be used. **(Rosenstiel *et al*., 2006).** Tissue management is critical for placement of direct restorative materials, whether these lesions are carious or non-carious cervical lesions, when these teeth need restoration, the cervical margin can be difficult to access due to both the extent of the lesion and the need for a dry, controlled field when placing the restoration **(Strassler and Boksman, 2011).**

3. Control of hemorrhage:

One of the main uses of hemostatic agents in combination with retraction cords is to control humidity and bleeding from the gingival sulcus during impression, so that a usually hydrophobic material may faithfully reproduce the details of tooth preparation. Control of hemorrhage is one of the challenging situations dentists confront during deep cavity preparation and before impressions or cementation of restorations **(Tarighi and Khoroushi, 2014).**

4. Recording subgingival margins during impression for indirect restorations:

The accurate impression of every detail of the prosthetic area is of extreme importance for the successful prosthetic restorations. One of the problems appearing in the process of fixed prosthetic restoration is the accurate impression of the marginal details. Contemporary dentistry uses hydrophilic impression materials (polyester, A-silikone) allowing operation in damp environments. However, appropriate gingival retraction of sulcus gingivalis is of utmost importance, as even the most modern nano impression materials are unable to guarantee an accurate marginal detail. A high-quality impression that provides the necessary marginal detail is not only required for good fit, but also for optimal esthetic results **(Abadzhiev, M., 2009).**

5. Better visualization of the preparation margins:

Numerous problems are faced in operative dentistry from the limiting influence of all the associated muscles to other hindrances caused due to limited vision and isolation **(D'Costa and Bangera, 2017).**

6. During crown lengthening procedures:

Intentional gingival retraction with provisional direct restoration appears to be useful for facial crown lengthening of teeth **(Marzadori *et al*., 2018).**

1.4 Gingival retraction techniques

The clinician can handle the gingival tissues during restoration and impression production using a number of procedures and materials. There is no scientific

evidence that one procedure is better than the other. The operator's preference and the clinical condition determine which of the different soft tissue management approaches is used to control the operative site.

According to ***Benson et al*** gingival retraction measures fall into one of three major categories:

I. Mechanical methods:
   a. Retraction cord.
   b. Anatomic compression caps.
   c. Copper Band.
   d. Anatomic compression caps.
   e. Rubber dam.

II. Chemo-mechanical methods:
   a. Impregnated Retraction cord.
   b. Cordless technique.

III. Surgical Methods of Gingival Retraction:
   a. Rotary curettage.
   b. Electro-surgical tissue displacement.
   c. Laser.

1.4.1. Mechanical methods

The mechanical part of this treatment entails inserting a string into the gingival sulcus in order to physically displace the tissues. The chemical element of the procedure entails treating the string with one or more compounds that will cause temporary tissue contraction while also controlling the bleeding and fluid seepage that frequently accompanies sub gingival margin preparation. In the present survey, chemical mechanical methods were preferred by the majority. This could be due to the marketing and availability of various medications more than before **(D'Costa and Banger, 2017).**

1.4.1.1 Retraction cord

The most common method in gingival retraction which is fast, simple and inexpensive is cord packing that can be used separately or in combination with hemostatic agents in two techniques: single cord or dual cord. Retraction cord penetration depth is influenced by the sulcus depth and periodontal status **(Hansen *et al.*, 1999).**

Using a cord is that it is inexpensive and can achieve varying degrees of retraction. But, cords can be painful and uncomfortable for the patient. Also the sulcus collapses soon after the removal of the cord. Hemostasis achieved is limited and the placement of the cord in the sulcus takes time **(Yang *et al.*, 2005).**

1.4.1.1.1 Retraction cords classifications:

Retraction cords can be classified according to their configuration as braided, twisted or knitted (figure 3). According to most dentists, braided cords are easier to work with and to apply with special packing instruments. When it comes to the knitted ones, they have the tendency to double in size when placed in the sulcus, and really open it. There is no good or bad type of retraction cord, it mostly depends on the knowledge and the preference of the dentist. They can also be classified according to their different sizes (figure 4):

#000 (Black): Use as lower cord in the double-cord technique, anterior teeth and double packing **(Greco *et al.*, 2015).**

#00 (Yellow): Restorative procedures dealing with thin, friable tissues **(Greco *et al.*, 2015).**

#0 (Purple): Lower anteriors, when luting near gingival and subgingival veneers, Class III, IV, and V restorations and Second cord for double-cord technique **(Greco *et al.*, 2015).**

#1 (Blue): #1 and #2 sizes are particularly effective for tissue control and/or displacement prior to and/or after crown preparations **(Greco *et al.*, 2015).**

#2 (Green): Upper cord for double-cord technique and used as a protective pre-preparation cord **(Greco *et al*., 2015)**.

#3 (Red): Areas that have fairly thick gingival tissues where a significant amount of force is required and as upper cord for use with the double-cord technique **(Greco *et al*., 2015)**.

, or according to lengths, and diameters. It also depends on the dentist whether they will decide to soak them in the hemostatic liquid or not **(Raja *et al*., 2003).**

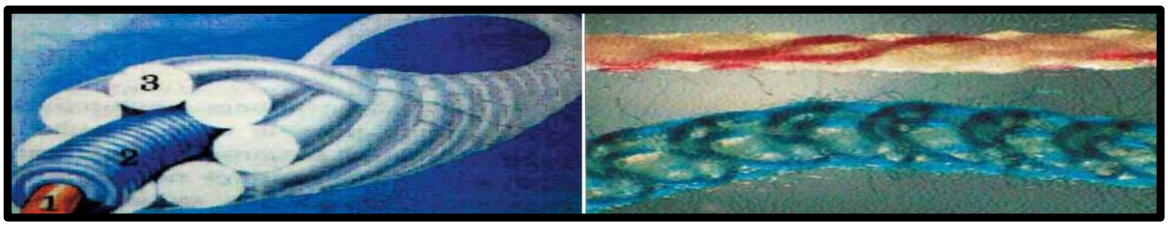

Figure 1-3. Braided" (3), Twisted" (white-red-upper) and "knitted" type (green lower) of cords **(Strassler, H.E. and Polhaus, J., 2006).**

Figure 1-4. Ultra pack retraction cord **(Ultra pack™ courtesy of manufacturer Centrix).**

1.4.1.1.2 Applying the gingival cord

1.4.1.1.2.1 Cord packing instrument

•The cord can be packed with special instruments like FISCHER PACKING instrument or a DE PLASTIC instrument IPPA. Some manufacturers make purpose-designed packing devices that have smooth, non- serrated (fig.5 A) circular heads that can be used to place and compress twisted cords with a sliding motion. Other manufacturers make devices with serrated circular heads (fig.5 B) for use with braided

cords. The thin edges of these serrated circular heads sink into the braided cord, and the fine serrations keep it from slipping off and cutting the gingival attachment.

•The instrument used for packing should be angled slightly towards the root to facilitate the subgingival placement of the cord.

•The instrument is inclined at an angle towards the tooth surface. If it is held parallel to the long axis of the tooth, the cord will rebound **(Baba *et al.*, 2014).**

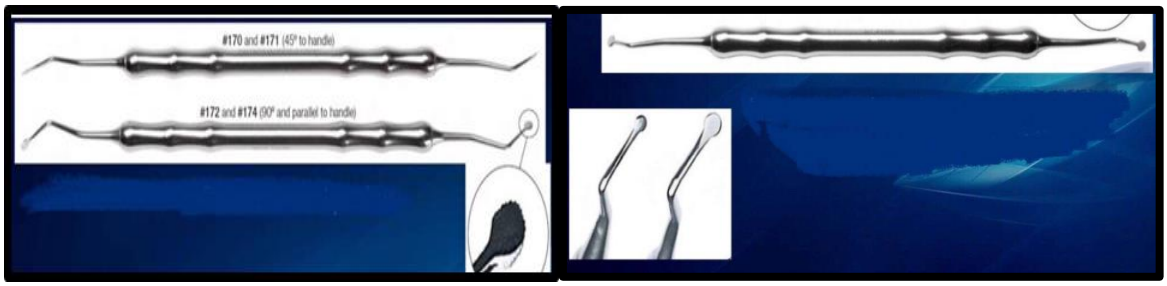

Figure 5.a Figure 5.b

Figure 1-5. Fischer packing instrument: serrated cord packer (a), Non-serrated cord packer (b) **(Baba *et al.*, 2014.).**

1.4.1.1.2.2 Important points to be considered:

- Fluid control should be done with an evacuation device to have a dry operating area **(Rosenstiel *et al.*, 2006).**
- Retraction cord is drawn from the dispenser flask and a piece of approximately 5cm is cut off **(Rosenstiel *et al.*, 2006)**.
- The cord is twisted to make it tight and small **(Rosenstiel *et al*., 2006)**.
- Occasionally it may be necessary to hold the cord with one instrument while packing with another **(Rosenstiel *et al*., 2006)**. (figure 6)
- Starting at the mesial surface of the tooth, the cord is packed into the gingival sulcus **(Rosenstiel *et al*., 2006)**.
- During cord placement, force should be applied in a mesial direction to avoid dislodging the packed preceding segment and the cord should be stabilized near the distal end of the tooth **(Rosenstiel *et al.*, 2006)**.

- At least 2-3 mm of the cord is left protruding outside the sulcus so that it can be grasped for easy removal **(Rosenstiel *et al.*, 2006)**.
- Excess cord is cut off near the interproximal area such that a slight overlap of the cord occurs in this region. If the overlap occurs on the facial and lingual surfaces, the gingival finish line in that area may not be replicated properly in the impression **(Rosenstiel *et al*., 2006**).
- The cord should be slowly removed after 10 minutes and only once the bleeding has stopped should the impression be taken **(Rosenstiel *et al*., 2006).**

  Note: The retraction cord must be slightly moist before removal. Removing dry cord from the crevice can injure the delicate epithelial lining of the gingival and cause haemorrhage **(Ghai *et al.*, 2013) (Baba *et al*., 2014).**

Figure 1-6. Retraction cord being placed with a plastic instrument **(Baba *et al.*, 2014.).**

1.4.1.1.4 Cord retraction time

The time for which the cord is placed in the sulcus is also an important consideration. If the cord is placed for less than the recommended time, the gingival tissues may not be adequately displaced for the impression material to record the subgingival preparation margin. If the cord is placed for only two minutes, the sulcus width is reduced to 0.1 mm within 20 seconds of cord removal. On the other hand, if the retraction cord is placed for a longer time, this could result in damage to the gingival tissue and recession. This is especially relevant for pre-impregnated cords or cords used with haemostatic agents. Cords placed in the gingival sulcus for too long

also have a chance of drying. If that happens, they adhere to the sulcular epithelium and tear the sulcular epithelium at the time of removal. The recommended time according to several studies ranges from 1–30 minutes. Also, the gingival sulci of all the prepared teeth should be checked after an impression has been made, so that no piece of cord is inadvertently left in the gingival sulcus **(Baba *et al*., 2014).**

1.4.1.1.5 Cord positioning force

Inserting the cord into the gingival sulcus with non-damaging minimal force is critical; otherwise, the displacement process can result in bleeding and damage to the sulcular and junctional epithelium. Due to a disruption in blood flow and damage to the periodontal attachment fibers, excessive use of force during cord placement can result in gingival recession later. There may be inadvertent excessive use of force while tucking the cord in the sulcus, particularly when the patient is anaesthetized. A study by **Phatal*e et al*** has shown that the epithelial attachment sustains injuries at a force of 1 N/mm2, while it ruptures at 2.5 N/mm2, which is almost the same force required to place the retraction cord **(Phatale *et al*., 2010).**

1.4.1.2 Anatomic retraction caps

The retraction caps follow the same principle as the copper bands, except that they are pre-shaped, for easy placement between adjacent teeth and, once in place, the patient bites on it (fig. 7) The physical pressure arrests haemorrhage and opens the sulcus for the final impression **(Thomas *et al*., 2011).**

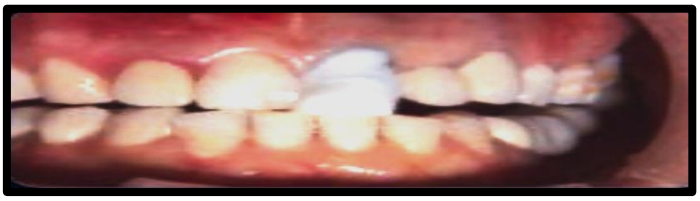

Figure 1-7. Anatomic retraction caps **(Thomas *et al*., 2011).**

1.4.1.3 Copper Band

Used to carry the impression material as well as to displace the gingival to expose the finish line.

1.4.1.2.1 Copper Band technique

- The copper band is welded to form a tube corresponding to the size of the prepared tooth.
- One end of the tube is trimmed to follow the outline of the gingival finish line. - Position and contour the tube over the prepared tooth.
- The tube is filled with modeling compound.
- The filled tube is seated carefully in place along the path of insertion of the tooth preparation Impression is made **(Darby and Darby III, 1973).** (Figure 9).

Note: The disadvantage of this technique is that it can cause injury to the gingival tissues **(de la Peña *et al*., 2015.).**

Figure 1-8. Gingival retraction using Copper Band **(Darby and Darby III, 1973).**

1.4.2 Chemico-Mechanical Methods of Gingival Retraction

1.4.2.1 Impregnated Retraction cord

The theory behind the chemico-mechanical approach of gingival retraction is that a retraction cord may be pre-impregnated with chemicals or plain retraction cords may be soaked in them before placement. It's a technique that combines a chemical with pressure packing to arrest haemorrhage and decrease the leaking of crevicular fluid. They can be vasoconstrictors that cause contraction of the blood vessels, AstringentsTM that contract the gingival tissue or chemicals that cease bleeding by haemostasis and coagulation. Some products are available in gel or liquid

formulation, which can be directly syringed into the gingival sulcus for arrest of bleeding and crevicular fluid and be followed by placement of the cord **(Kellam *et al*., 1992).**

1.4.2.1.1 Ideal Requirements for Chemicals used with Retraction Cord

- Should produce effective gingival displacement **(Gupta *et al*., 2016)**.
- Should produce hemostasis **(Gupta *et al*., 2016)**.
- Should not produce any irreversible damage to the gingival tissue **(Gupta *et al*., 2016)**.
- Should not have any systemic side effects **(Gupta *et al*., 2016)**.

The chemicals can be classified according to their mode of action **(Gupta *et al*., 2016)**. (Table 1-1)

Table 1-1. Classification of chemical agents used in gingival retraction according to mode of action **(Gupta *et al*., 2016).**

Vasoconstrictors	Biologic fluid coagulants	Surface layer tissue coagulants
Epinephrine	15.5–20% Ferric sulfate	8% $ZnCl_2$
	100% Alum.	
Nor–epinephrine	15−25% $AlCl_3$	
	10% Aluminium_ potassium sulfate	Silver nitrate
	15−25% Tannic acid	

1.4.2.1.2 Cord packing technique

Depending on the clinical setting, the condition of the gingival tissues, the depth of the gingival sulcus, and the location of the margin of the preparation on the tooth

structure, there are two widely used ways for packing retraction cord in the gingival sulcus. According to a survey conducted by Sorensen et al., 98% of prosthodontists employ cords, with 48% using a dual cord approach and 44% using a single cord technique **(Sorensen *et al.*, 1991)**.

1.4.2.1.2.1 Single cord technique

This is a relatively straightforward method, usually employed for single teeth, with healthy gingival tissue. The gingival sulcus is packed with a single piece of retraction cord, which is then removed once appropriate gingival displacement has been accomplished. The edges of the tooth preparation can then be imprinted. When there is little or no gingival sulcus bleeding and the preparation borders on the tooth are gingival or slightly subgingival hydrated potassium aluminum sulfate, it is a good procedure **(La Forgia, 1964).**

1.4.2.1.2.2 Double cord technique

In dual cord technique, two knitted cords with different diameters are used. The apical cord is thinner soaked with haemostatic agent into the depth of the sulcus, causing some lateral tissue displacement but primarily controlling haemorrhage and is kept in place during impression making (fig). However, using the mentioned method is limited in supra-gingival preparation margins. Unpredictable tissue resorption and patient's discomfort are problematic issues associated with Dual Cord technique **(Scott, 2005).**

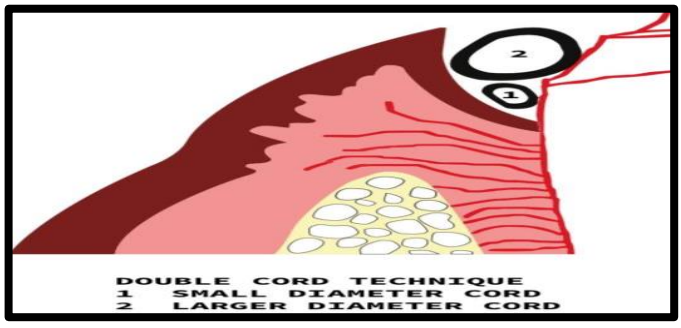

Figure 1-9. Double cord technique **(Wassell *et al.*, 2002).**

1.4.2.2 Cordless methods

Histological investigations have shown that when a retraction cord is implanted, the gingival tissue suffers some damage. The amount of force needed to put the cord in the gingival sulcus determines the amount of damage. When a cordless retraction technique was applied, there was less tissue damage.Pastes, foam, and gel are offered as materials for the cordless retraction technique. They offer the benefits of being soft on the gingival tissue during installation, leaving no residue, being simple to apply, and time saving. When gingival retraction cords and cordless retraction techniques were evaluated, it was discovered that cordless retraction techniques applied much less pressure (143 Kpa) to the gingival tissue than gingival retraction cords (5396 Kpa). Most products, however, have no hemostatic capability. Therefore, they may not be applicable in situations where there is laceration of gingival tissue, excessive haemorrhage or deep gingival sulcus **(Bennani *et al*., 2012).**

1.4.3 Surgical Methods of Gingival Retraction

Some approaches used to improve visualization of the tooth's preparation margins aren't true retraction techniques. This is due to the fact that they remove some or all of the underlying gingival tissue in order to reveal the preparation's finish line and/or prevent bleeding. These procedures are more intrusive and should only be utilized in cases where the gingiva is sufficiently attached. The following are some of these methods **(Kamansky *et al*., 1984).**

1.4.3.1 Rotary curettage

1.4.3.1.1 Gingettage Procedure

- In this technique, a suitably shaped diamond bur (tapered fissure bur in most cases), is gently rotated around the gingival sulcus, slightly apical to the preparation margin, removing the lateral aspect of the gingival tissues. It helps to reduce the excessive tissue and can also help to contour the gingival outline.
    - A retraction cord can then be placed in the trough created, to control haemorrhage and subsequently the impression can be made.

- A copious amount of water is needed when using this technique.
- It is only recommended for healthy gingival tissues **(Kamansky *et al*., 1984).**

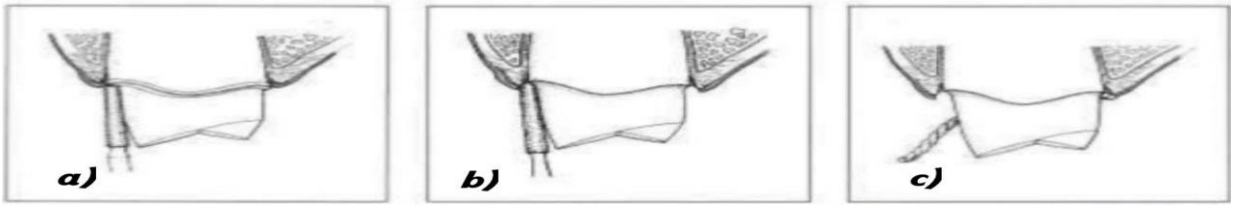

Figure 1-10. Rotary curettage, (a) A shoulder finish line is prepared, (b) Converting the finish line to chamfer using diamond bur (c) Placing retraction cord **(Kamansky *et al*., 1984).**

1.4.3.1.2 Criteria for gingettage

- The absence of bleeding upon probing from the gingival **(Kamansky *et al*., 1984)**;
- The depth of the sulcus is less than 3mm **(Kamansky *et al*., 1984)**;
- Presence of adequate keratinized gingiva **(Kamansky *et al*., 1984)**.

Because gingival tissue removal necessitates the presence of sufficient keratinized connected gingiva, case selection is critical. Use of this method causes gingival recession and sulcus deepening if keratinized tissue is not present. The results of this treatment are unclear, with thin gingival biotypes having a higher risk of gingival recession. The tissue response has been compared to electro-surgical tissue excision. However, this technique should be utilized with caution and, in cases where an aesthetic deficit is created, would not be readily visible **(Kamansky *et al*., 1984) (Al-Ani *et al*., 2010).**

1.4.3.2 Electro-surgical tissue displacement

This technique is frequently used in conjunction with retraction cords, especially in cases of gingival hyperplasia, excessive haemorrhage, and, subgingival preparation margins and to widen the gingival sulcus. If not used carefully, like all tissue removal methods, there is a risk of excessive tissue removal and recession. The tip should be

carefully placed so that the bone or cementum is not touched. If the electro-surgery electrode comes into contact with any metallic filling, adverse effects on the pulp and periodontium are observed.Also, this technique is contraindicated for patients who have cardiac pacemakers or cardioverter defibrillators because the electromagnetic interference caused by the electrosurgical equipment can cause the cardiac defibrillators to malfunction. As far as the healing of the soft tissues after the use of electro-cautery is concerned, there was no significant difference between the wound healing when electro-surgery and scalpel were compared but, when used for deeper tissues or for longer periods of time, more damage and delayed healing was observed. However, electro surgery is not recommended as the concentrated electrical current at the tip of electrodes can generate heat, which may cause osseous or mucosal necrosis and also there is a potential for gingival recession after treatment **(Cook and Lim, 2019).**

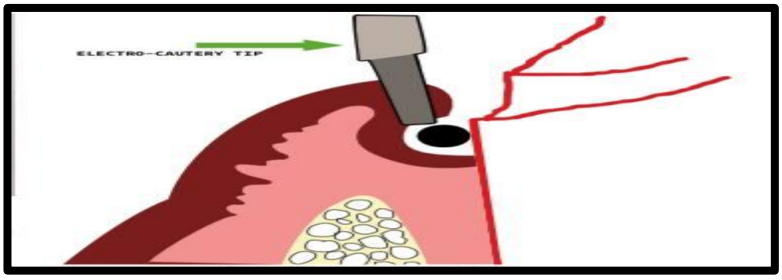

Figure 1-11. Electro-surgery: with excessive gingival growth, the tissue be removed **(Cook and Lim, 2019).**

1.4.3.3 Laser

Latest advances in dentistry have allowed the utilization of lasers for haemostasis and tissue removal. The soft tissue inside the gingival sulcus can be removed in order to visualize the preparation margins for an accurate impression. Although Diode lasers have been most commonly utilized for the purpose, Nd:YAG and Er:YAG lasers can also be used. There are studies indicating that gingival tissue displacement with lasers is less painful and can even be used without anesthesia in selected cases. Tissue shrinkage is less through scarring, which helps to preserve gingival margin

heights; also they result in minimal postoperative pain, haemorrhage and gingival recession **(Scott, 2005).** However, lasers run at higher operating cost and take more time to remove tissue than with electro-cautery or using a scalpel. Visualizing the action of laser beams are difficult, owing to the plume of coolant water. Therefore, there is potential for attached gingiva to be obliterated when lasers are used for retraction purposes, since clinicians receive virtually no tactile feedback **(Parker, 2004).**

1.5 Gingival retraction materials

Based on the method of application, gingival retraction materials can be categorized into three groups: the material's gingival hemostatic agents, gingival retraction cords/caps, and gingival retraction paste/gels (Table2) **(ALBAKER, 2010).**

1.5.1 Gingival Hemostatic Agents

It can be classified according to their mode of action as:

- Epinephrine, although its use for this purpose has declined over time, epinephrine has been the most commonly utilized chemical for impregnating retraction cords. The most common concentration is 8% racemic epinephrine, however other concentrations have been employed as well. The systemic effects of epinephrine have been a matter for concern, especially if the gingival tissues have been lacerated, due to the high vascularity of the gingival tissue. The 'epinephrine reaction' or 'epinephrine syndrome' is a systemic impact of epinephrine that is linked to the usage of epinephrine-soaked retraction cords. This is characterized by tachycardia, increased blood pressure, nervousness, anxiety and increased respiration. One study indicated that there was almost 50 times more epinephrine in 1 inch of retraction cord as in 1 cartridge of 1:100,000 epinephrine **(Felpel, 1997).** This shows how epinephrine-impregnated cords should be used with caution in patients with a history of cardiovascular disease. Some of the effect exerted by epinephrine can be avoided by using it in diluted form and for the minimum amount of time needed for retraction.

- AstringentsTM have gained in popularity as adjuvants in gingival tissue retraction due to minimal systemic side- effects. They cause tissue retraction as well as haemostasis by reducing the elasticity of the collagen fibers in the gingival tissues around the tooth. This aids in keeping the sulcus open even after the retraction cord has been removed. They also decrease the oozing of crevicular fluid from the gingival sulcus, which improves visibility, makes a good impression more likely and also improves bonding for adhesive restorative procedures **(Jokstad, 1999).**
- Ferric sulfate (15.5−20%) When performing concomitant gingival displacement, is typically used as a coagulant. The elimination of the smear layer while employing ferric sulfate for more than 10 minutes is one of the issues. Patients may experience sensitivity following the procedure as a result of this. Due to its high iron content, ferric sulfate can leave a residue on the tooth surface, which can impede impression setting and stain the dentine **(Conrad, and Holtan, 2009).** Furthermore, the residue can interfere with the bonding of composite to the tooth. If ferric sulfate is to be used with the retraction cords, the sulcus should be washed out after removal of the cord and prior to impression-taking **(O'Mahony *et al.*, 2000).**
- Because they have no systematic effect, alum and aluminum sulfate are considered the safest astringents. However, they are less effective at controlling haemorrhage and crevicular exudates. They're only used in a few gingival retraction techniques **(Donovan *et al.*, 1985**).
- Zinc chloride (bitartrate) and silver nitrate both physically cause haemostasis and precipitation of protein on the mucosal surface, resulting in coagulation. Zinc chloride is available in 8% and 40% concentrations but its use has been associated with soft-tissue injury and hence is no longer recommended **(Gupta *et al*., 2012).**

1.5.1.1 Hemostatic Agents disadvantages

The presence of epinephrine in impregnated cord could result in tissue necrosis, when the cord is placed for longer than the recommended time. The cord packing procedure

may also lead to bleeding and is uncomfortable to the patient, and hence local anesthesia is frequently required **(Phatale *et al.*, 2010).**

Table 1-2. Gingival Hemostatic Agents products **(ALBAKER, A.M., 2010).**

Product Name (Company)	Material Type	Dispensor Type	Composition
Hemostasyl™ Hemostaic Agent (Kerr Corporation)	Gel	Syringe	15% Aluminum Chloride
FS Hemostatic Products Company)	Solution	Dropper bottle, Bottle	15.5% ferric sulfate
Astringedent (Ultradent)	Solution	Bottle	15.5% ferric sulfate
Hemodent (Premier Products Company)	Inquire	Bottle	Bufered Aluminum Chloride

1.5.2 Gingival Retraction Cord/Caps (Table3)

Table 1-3. Gingival Retraction Cord and Caps products **(ALBAKER, A.M., 2010).**

Product Name (Company)	Sizes available	Sizes available	Medicated
Hemodent Retraction Cord, (Premier Products Company	Braid: Thin, Medium-Thin Twist:3, 9		Not medicated
CrownPak (GingiPak)	4-ply	Kutter Kap	Epinephrine HCl
GingiAidZ-Twist (GingiPak)	0,1,2,3	Kutter Kap	Aluminum Sulfate
Gingiplain Soft (GingiPak)	1,2,3	Kutter Kap	Non-impregnated

Product Name (Company)	Sizes available	Sizes available	Medicated
Pascord (Pascal Company, Inc)	7,8,9,10		Aluminum Sulfate.
Racord (Pascal Company, Inc	7,8,9,10		Racemic Epinephrine HCl.
Racord II (Pascal Company, Inc	7,8,9,10		Reduced Racemic Epinephrine HCl And Zinc Phenosulfonate.
Sulpak (Sultan Healthcare)	Small, Medium Large	Pull 'n Cut Dispenser	Astringent-Aluminum Potassium Sulfate Vasoconstrictor - 4% Racemic Epinephrine HCl; and Combination - Aluminum Potassium Sulfate and 4% Racemic Epinephrine.
Ultrax (Sultan Healthcare)	Small, Medium Large	Pull 'n Cut Dispenser	Astringent-Aluminum Potassium Sulfate Vasoconstrictor - 4% Racemic Epinephrine HCl; and Combination - Aluminum Potassium Sulfate and 4% Racemic Epinephrine.
Unibraid (Van R)	0, 1, 2		Epinephrine/Alum 87 or Aluminum Potassiumn Sulfate.

1.5.3 Gingival Retraction Paste/Gels

1.5.3.1 Expasyl

Expasyl is a universally accepted and widely used gingival retraction paste. It is made up of three components: aluminum chloride (≈15%), kaolin, and excipient. The product is supplied in reusable capsules (Figure 11). A single capsule can do four to ten preparations, depending on the clinical circumstances and number of teeth **(Pescatore, 2002).** Expasyl's consistency is especially formulated to avoid damaging the healthy periodontium, preventing gingival recession and bone resorption. A single application of Expasyl in the sulcus causes gingival retraction. When this substance comes into contact with crevicular fluid, it causes mild gingival displacement within two minutes **(Al Hamad *et al*., 2008).** Expasyl, which is clearly visible due to its color, is simply removed with an air and water spray, resulting in a dry and widely opened sulcus. When applied on a healthy periodontium, it is painless. Absence of bleeding or oozing allows achieving a perfectly dry sulcus **(Poss, 2002).**

Figure 1-12: Expasyl and Applicator Gun **(Pescatore, 2002).**

1.5.3.2 Magic foam cord

This material is based on polyvinyl siloxane, once inside the gingival sulcus, it has the ability to expand and displace tissues. This is utilized in conjunction with a compression cap that the patient bites hard on, followed by the assembly being removed and the degree of retraction being assessed. The final impression can be produced if the retraction is satisfactory **(Donovan and Chee, 2004).**

1.5.3.3 GingiTrac

To encircle the teeth, this product is used in conjunction with fomic cylinders. These cylinders come in two sizes: large and regular. The procedure involves inserting

a polyvinyl siloxane paste into the gingival sulcus. This is followed by placing the foamic cylinder filled with more of the retraction paste onto the tooth and directing the patient to exert biting pressure for 3−5 minutes, until the material sets. This is followed by removal of this assembly, and observation of the degree of retraction. If satisfactory, the final impression can be made, otherwise the procedure can be repeated. This is a simple approach that causes less damage to the gingival tissue. When using this product, be careful not to wear latex gloves **(Sharma *et al.*, 2014).**

Figure 1-13. Gingival retraction system with foamic cylinders and polyvinyl siloxane paste **(GingiTrac™ courtesy of manufacturer Centrix).**

2.1 Summary

Gingival retraction is an important part in the prognosis or longevity of fixed dental prosthesis. A thorough knowledge of the retraction techniques and materials is required to gain the adequate retraction simultaneously with good haemorrhage control. The selection of method and gingival retraction material used are frequently determined by the clinical situation. The extent of haemorrhage influences the preference for a specific retraction cord. Dentists should carefully assess the benefits and drawbacks of various materials and procedures of gingival retraction.

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