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Vertical tooth preparation in crown and bridge

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CERTIFICATION OF SUPERVISOR

I certify that this project entitled **"Vertical tooth preparation in crown and bridge"** was prepared by **Fadul Allah Basem** 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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Dedication

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and patience.

Every challenging work needs self efforts as well as guidance of elders especially those who are close to my heart.

My humble effort I dedicate to my sweet and loving father, mother,

brothers and sister whose affection, love, encouragement and prays

of day and night make me able to get such success and honor.

And at last I dedicate to my close friends for their support, love and care and to my dear supervisor with special appreciation**.**

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List of abbreviation

BOPT	Biologically Oriented Preparation Technique
CEJ	cemento-enamel junction
PCEJ	Prosthetic cemento-enamel junction
BW	biological width
APT protocol	aesthetic pre-evaluative temporary protocol
3D	three-dimensional
IDS	immediate dentin sealing

1. Introduction

Tooth preparation is the mechanical alteration of a defective, injured, or diseased tooth to receive a restorative material that re-establishes a healthy state for the tooth, including esthetic corrections where indicated and normal form and function. Included in the procedure of preparing the tooth is the removal of all defective or friable tooth structure because remaining infected or friable tooth structure may result in further caries progression, sensitivity or pain, or fracture of the tooth or restoration or both **(Boushell et al., 2014).**

Generally, the objectives of tooth preparation are to (1) remove all defects and provide necessary protection to the pulp, (2) extend the restoration as conservatively as possible, (3) form the tooth preparation so that under the force of mastication the tooth or the restoration or both will not fracture and the restoration will not be displaced, and (4) allow for the esthetic and functional placement of a restorative material , Much of the scientific foundation on which these objectives are executed was presented by Black **(Black GV ,1947-1948)**.

The fundamental concepts relating to conventional and modified tooth preparation are the same: (1) No friable tooth structure can be left; (2) the fault, defect, or caries is removed; (3) the remaining tooth structure is left as strong as possible; (4) the underlying pulpal tissue is protected; and (5) the restorative material is retained in a strong, esthetic (in some cases), and functional manner. Conventional preparations achieve these concepts by specific, exact forms and shapes. Modified preparations are usually smaller and have more variable and less complex forms and shapes **(Boushell et al., 2014)**.

Tooth preparations for fixed prosthetic restorations can be performed in different ways. There are basically two kinds of preparation: 1) preparation with defined margin, and 2) the so-called vertical (or feather-edge) preparation **(Loi and Di Felice, 2013).**

Vertical preparation without a finish line is a technique whereby the abutments are prepared by introducing a diamond rotary instrument into the sulcus to eliminate the cementoenamel junction and to create a new prosthetic cementoenamel junction determined by the prosthetic margin **(Agustín-Panadero et al., 2016).**

vertical preparation is commonly indicated where periodontally involved teeth are being used as abutments for fixed prostheses. This approach may represent a less-invasive alternative to a horizontal margin in various clinical conditions **(DiFebo et al., 1985)**.

The vertical preparation technique, when compared to other preparation techniques (chamfer, shoulder, etc) is simpler and faster in terms of clinical steps. Vertical or Shoulderless Preparations in Contemporary Prosthodontics means a tooth preparations without a defined finish line that have been termed in several different ways, such as knife edge, feather edge, or shoulderless. With slight differences between each other, all this preparation types may be defined "vertical" as opposed to "horizontal" ones (shoulder, chamfers) and since the introduction of metal ceramic they have been almost abandoned, with limited exceptions (i.e.: periodontically involved abutments) **(Hülsmann et al., 2005)**.

From a biological standpoint, preserving a maximum amount of sound tooth structure, as it is done in vertical preparations, might also offer a more conservative alternative to a horizontal margin design in other clinical conditions such as endodontically treated teeth, vital teeth in young individual, teeth affected by caries at the cervical third **(Özcan, 2021)**.

Vertical margins on zirconia crowns have been tested in vitro and clinical reports have been published **(Labno and Drobnik, 2020)**.

Figure 1: Fixed dental prosthesis with vertical tooth preparation without finish lines.

Figure 2 : Vertical or shoulderless preparation in contemporary prosthodontics.

2. The definition of the vertical margin

The finish line is the border between the tooth and the most apical point of the preparation **(Castellini, 1994).**

The finish line may be:

a) Linear Finish Line (sometimes known as "Horizontal Margin").

This is where there is a distinct finish line and the clinician defines with a burr the exact position where the restoration should finish on the tooth. The technician then fabricates the restoration to this margin. See Figure 3 (prepared margin) and Figure 4 (crowns on recall) **(Castellini, 1994).**

Figure 3: Prepared margin.

Figure 4: Crowns on recall.

Linear finish lines may be simple (for example, a chamfer or shoulder) or complex (a shoulder with a bevel).

b) Area Finish Line (also known as "Vertical Margin").

In this approach there is a finishing area rather than a line. The clinician defines an area where the crown margin may finish. The clinician and technician then collaborate to determine a finish line position that will give optimal esthetics, biomechanics, and periodontal health **(Jason Smithson, 2021).**

See Figure 5 (prepared tooth, observe no apparent margin) and Figure 6 (final outcome; full coverage monolithic zirconia crowns on both upper lateral incisors). The area finish line may be either feather-edged (where the axial wall meets the root at 180 degrees) or knife-edged (where the axial wall meets the root at less than 180 degrees) **(Boldaji, 2006)**.

Figure 5: Prepared tooth, observe no apparent margin.

Figure 6: Final outcome; full coverage monolithic zirconia crowns on both upper lateral incisors

3. Indications of vertical preparation

- Restoration of patients with advanced periodontal disease: When a patient has recession and an exposed root face it is often desirable to finish at the gingival margin to optimize esthetics. However, preparing a root face for a linear margin obviously requires cutting into the root and may run the risk of devitalization of the tooth or a reduction of the biomechanical performance of the tooth risking fracture. The vertical margin requires no preparation of the root at all and is therefore more conservative in these cases **(Jason Smithson, 2021).**

- Restoration of endodontically treated teeth: For the same reason as above the vertical margin does not compromise the horizontal ferrule of root treated teeth **(Jason Smithson, 2021)**.
- Provision of splinted crowns: Used to stabilize mobile teeth multiple units of cross-arch braced crowns can be difficult to prepare with parallel paths of insertion. The vertical margin makes this a simpler proposition since the technician has some degree of flexibility in margin positioning and can compensate for minor alignment errors **(Goodacre et al., 2001).**
- Preparation of crowns with a previous biologic width invasion: The existing horizontal margin (if minimal depth) can be deleted during the preparation of a vertical margin. If the margin of the provisional crown is placed more coronally than the previous margin the tissue can re-establish a healthy biologic width without the need for crown lengthening surgery. This is often advantageous with challenging crown: root ratios **(Ingraham et al., 1981).**

4. Main Advantages of vertical preparation

- Minimally invasive in the cervical area.
- Saves dental structure and allows enamel preservation in the cervical area. In fact, this approach may contribute to limiting pulpal irritation in vital teeth as a consequence of a well-preserved pulp-preparation distance in the cervical area, which represents the most sensitive zone for the pulp **(Wisithphrom et al., 2006)**.
- Possibility of positioning the final finish line at different levels, either more coronally or more apically within the gingival sulcus, without affecting the quality of the restoration’s marginal adaptation.

- Possibility of modulating the emergence profile.
- Easy and fast to execute.
- Ease of impression taking.
- Ease of provisional manufacturing and finishing.

Moreover, the introduction of high strength ceramics has allowed the clinician to use this margin preparation also in full-ceramic restorations. The vertical finish line has already been tested in vitro and in vivo with zirconia crowns. Furthermore, in vitro and clinical observations reported results with high success rates with lithium disilicate full crowns on vertical preparations **(Imburgia et al., 2016)**.

Figure 7: Minimally invasive vertical preparation design

5. Main disadvantages and drawback of vertical preparation compared to the horizontal

For many years tooth crown preparation with vertical finish lines (knife edge, feather edge) has been a method of treatment by choice due to the applied technique of making Scharp's crowns. The implementation of metal-casting technology made it possible to produce prosthetic crowns on shoulder-prepared abutments with horizontal finish lines (shoulder and chamfer). It was then possible to compare both methods, and the following drawbacks of vertical preparation were most often noticed: overhangs, uneven edges, biological width

disruption, lack of aesthetic appearance, over-contouring, difficulty of determining a finishing line, lack of control on marginal seal and integrity, damage to the epithelial attachment and unpredictable tissue healing, difficulties in removing cement excess, etc. Many disadvantages of vertical finish line made shoulder preparation become acknowledged by the academic world as the gold standard **(Shillingburg et al., 2003)**.

There is currently a dissonance in everyday practice of a dental prosthetist between preserving red white aesthetics where a significant amount of tooth structure is removed to achieve correct chamfer or shoulder finish line, and planning minimally intensive preparation which requires quite the opposite **(Asavapanumas and Leevailoj, 2013).**

6. The challenges of the vertical margin

- **Esthetics**: this margin design is unsuitable for porcelain-fused to metal crowns since a visible metal margin will result**.**
- **Stress-distribution:** If not carefully managed this margin creates high stress distributions in comparison with other margin types during firing and when occlusally loaded **(El Ebrashi et al, 1969).**

This may result in a margin which is weak in tension and therefore subject to distortion. In view of this, the vertical margin is only suitable for porcelain fused to metal crowns with a metal collar (for non-esthetic zones, e.g. lower molars) or zirconia crowns. Some recent research has also seen success with lithium disilicate **(Kuwata, 1989).**

7. Vertical Margin in Fixed Prosthodontics

The vertical margin in full veneer crown preparation can offer an esthetic, minimally invasive and biocompatible solution for teeth that are periodontally or structurally compromised . For example, the case below (Figures 8-11), which was restored as a fixed-removable combination case **(Jason Smithson, 2021)**.

Figure 8: Existing crowns failing at the margins.

Figure 9: Old crowns removed demonstrating large chamfer and dentin margins.

Figure 10: Caries and old restorative removed, repreparation with vertical margin (minor tissue trauma seen immediately post preparation/gingitage).

Figure 11: Final zirconia crowns showing nice aesthetic outcome and tissue health.

8. Comparison of horizontal and vertical methods of tooth preparation for a prosthetic crown

Tooth preparation for a prosthetic crown is always invasive in character and leads to irreversible loss of tooth hard tissues. In the case of tooth preparation with vital dental pulp there is a risk of its irritation, inflammation, necrosis, and endodontic treatment in the future. A variety of attempts have been made in dental prosthetics to develop the best method of tooth preparation, which – on the one hand – would ensure adequate marginal fit, emergency profile, and on the other hand would lead to the least loss of enamel and dentine in the preparation process **(Tripathi et al., 2014)**.

9. The scope of abutment preparation

It depends on a series of factors, such as: crown convexity, patient's age, vitality of the pulp, degree of inclination, material of the future crown, and size of its structure (single crown or extensive bridge). Taking into consideration the fact

that the prepared tooth should be reduced by the size of the prosthetic crown, together with the optimal path of its insertion, enamel and a significant part of the dentine is lost during such preparation. Further preparation is required for providing adequate space for the metal and / or ceramics which does not exceed the biological width, and which ensures the adequate strength of the material subjected to the occlusal forces **(Schmitz et al., 2017).**

10. Vertical preparation approaches

10.1 Vertical preparation – shoulderless approach

the shoulderless type of tooth crown preparation (also known as bevel preparation) has been referred to differently according to the rising taper: feather edge, knife edge, chisel edge, but researchers agree that for many years it has been the most conservative approach towards dental structure and the less prone to marginal gap **(Limkangwalmongkol et al., 2007).**

The historical method was to restore the tooth structure with a Scharp's crown, which was possible even in case of non-parallel preparation thanks to the soft alloy. At present, shoulderless preparation has been practically abandoned due to the application of modern - laboratory technologies and to its numerous defects **(Piemjai, 2001)**.

Figure 12 : Shoulderless vertical prepation (Molar restoration with a shoulderless crown).

10.2 Vertical preparation – edgeless approach

The ‘rotary gingival curettage’ (gingitage, vertical prep, edgeless) method, originally developed by Vick Pollard and Rex Ingraham, has been further developed by Di Febo, Carnevale, and more recently by Ignazio Loi **(Loi and Di Felice, 2013)**.

It is also known as the ‘biologically oriented preparation technique’ (BOPT) and consists of 1) placing the finish line subgingivally, 2) sealing the preparation coronally to the finish line, and 3) shaping the natural edge of an emergence profile above the cemento-enamel junction (CEJ, with the creation of a new prosthetic emergence edge adjacent to the gingival edge (prosthetic cemento-enamel junction / PCEJ). The boundary range of this preparation may be located at different depths of the gingival pocket, depending on the available biological width **(Comlekoglu et al., 2009)**.

Adversaries of the method claim that it often results in irreversible damage to the periodontal attachment and violates the biological width. Supporters, however, pay attention to using special round-ended 2 degrees tapered diamond burs a non-working tip (batt bur). It has coronal diameter of 1.2 mm, apical diameter of 0.7 mm, and non-cutting end of 1 mm, which reduces or avoids damage to the connective attachment and allows a **t**ooth-guided preparation procedure. The length of the non-cutting end and its width should be chosen according to the biological width (BW) **(Lang et al., 1983)**.

Rotary curettage leads to minor bleeding but is limited only to oral sulcular epithelium. According to research results, such new epithelium is thicker and adheres closely to a new prosthetic restoration; however, it is conditioned by manufacturing a very precise, smooth and polished temporary and final reconstruction **(Ramos et al., 2017).**

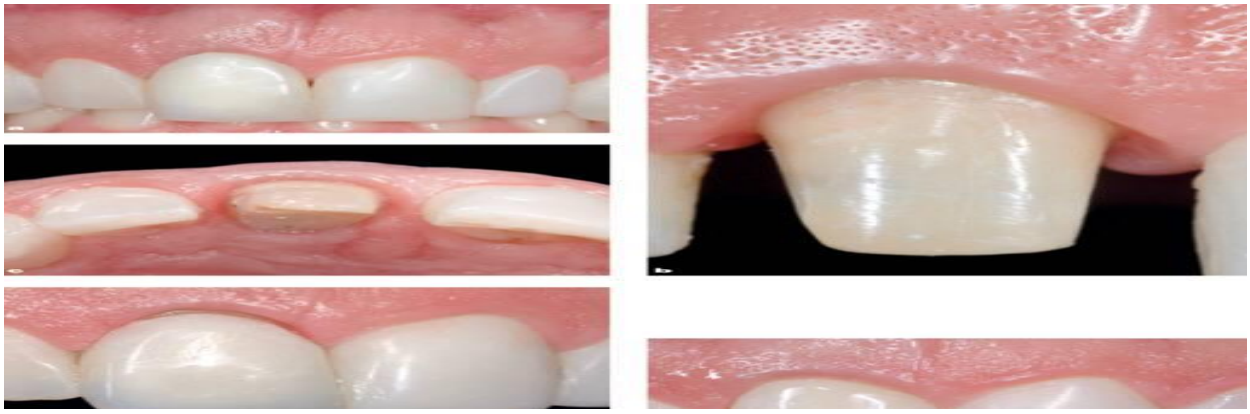

Figure 13: Biologically oriented preparation technique (BOPT)

An emergency profile of a crown placed on the shoulderless abutment should be smaller than in case of an edgeless abutment, where gingival tissues need a support for predictable growth. This means that the final restoration will be over-contoured by conventional standards **(Labno and Drobnik, 2020)**.

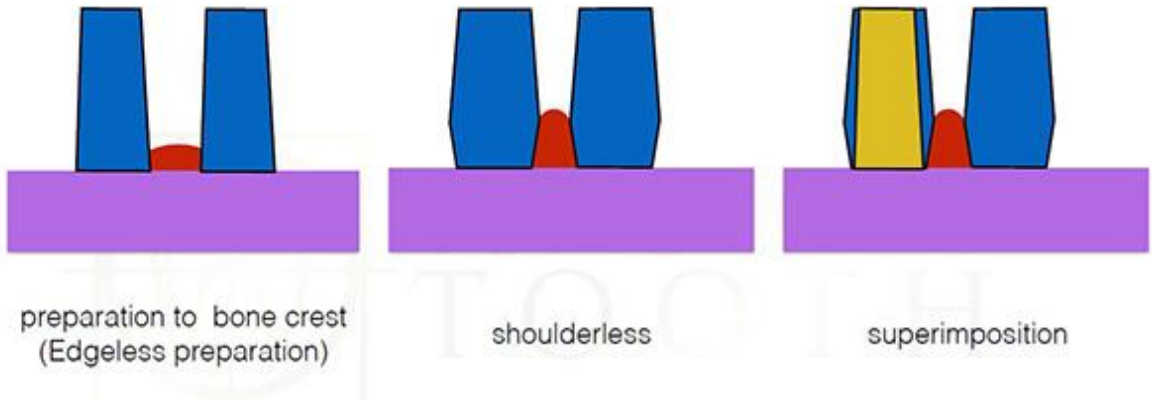

Figure 14 : Over-contouring required for a better papilla growth predictability in edgeless preparation

11. Advantages and disadvantages of different preparation techniques

11.1 Horizontal preparation

A- Advantages **(Labno and Drobnik, 2020)**

- No over-contouring, avoidance of overhangs.

- Low risk of porcelain chipping due to limited stress within the cervical area.
- Preservation of biological width.
- Preparation depth provides space for colour changes within cervical area.
- Good cooperation with laboratory leads to clear definition of the margins of preparation and precise determination of its position and tightness.
- Easy elimination of cement excess.
- No damage to the epithelial attachment and predictable tissue healing.

B- Disadvantages **(Ichim et al., 2006)**

- High risk of post-operative complications, e.g. hypersensetivity, inflammation, pulp necrosis, endodontic treatment in the future.
- Loss of hard tooth tissue by 50-60%.
- Exposure of dentine which facilitates penetration of bacteria in the case of bacterial micro-leakage.
- Lack of marginal seal due to imperfections of technology and workmanship (marginal gap).
- Lack of ferrule (tooth structure removal and stress concentration).
- More complicated procedure in relation to vertical preparation.

11.2 Vertical preparation – shoulderless

A- Advantages **(Smith, 1957)**

- Small loss of tooth hard tissue.
- Good marginal seal and integrity.
- Preparation mostly within enamel and little within dentine.
- Reduced number of post-operative complications, e.g. pain,

hypersensitivity, pulp inflammation, need for endodontic treatment.

- Thin layer of ceramics within the cervical area may result in a change in the colour of its crown.
- Ferrule preservation.
- Good retention.
- Easy tooth preparation.

B- Disadvantages **(Paniz et al., 2017)**

- Unaesthetic (thin, opaque porcelain layer in cerviacal area).
- Present overhangs, uneven edges.
- Causing damage to the epithelial attachment and unpredictable tissue healing.
- Waiting time for tissue healing at the stage of temporary restorations – 6 weeks.
- Porcelain chipping due to stress within the cervical area.
- No control on marginal seal and integrity.
- Biological width disruption.
- Not possible to assess the final fit of a crown.
- Difficult cooperation with laboratory, especially in terms of providing information on the proper range of prosthetic restoration.
- Difficulties in removing cement excess.

11.3 Vertical preparation – edgeless

A- Advantages **(Agustín-Panadero et al., 2016)**

- Small loss of tooth hard tissue.

- Preparation mostly within enamel and little within dentine, which provides protection for remaining part of the tooth, consequently reducing pain thanks to the possibility of conducting preparation without anaesthesia.
- Reduction of post-operative complications, e.g. pain, hypersensitivity, pulp inflammation and necrosis.
- Low risk of creating a marginal gap.
- No damage to the epithelial attachment; predictable tissue healing.
- Ferrule preservation.
- High friction due to low wall convergence**.**

B- Disadvantages**(Agustín-Panadero et al., 2016)**

- Demanding work due to the applied instrumentation; operational microscope , intraoral scanner , dental model printer.
- High level of difficulty of clinical operations.
- Quite narrow range of application at the moment; zirconium-oxide based restorations.
- Difficulties in removing cement excess.
- No control of marginal seal and integrity.
- Not possible to assess the final fit of a crown.
- Waiting time for tissue healing at the stage of temporary restorations – 2 weeks.
- Small number of prospective clinical research studies assessing the efficacy of this method.

12. Technique description of Minimally invasive vertical preparation design for ceramic veneers

Before starting the procedure, a careful esthetic and functional evaluation of the patient must be made, a carefully defined treatment plan and good communication between the clinician and the technician helped to maximize the efficiency of the treatment and the predictability of the esthetic outcome (figures 15-17) **(Coachman and Calamita, 2012).**

Figures 15,16, and 17: Preoperative views of the clinical case. The patient complained of numerous discolored teeth and changes in form and color, as well as the visibility of previous restorations that were stable.

The clinical approach to preparation is founded on the selective reduction of tooth substance guided by a mock-up that mimics the golden reference: the wax-up itself. Regarding of thickness control, the preparations were performed according to the aesthetic pre-evaluative temporary (APT) protocol **(Gurel et al., 2012)**.

With this technique, after a three-dimensional (3D) smile design analysis, the clinician gives all the information and clinical records to the technician to execute the diagnostic wax-up. A digital analysis of the clinical picture is performed to evaluate the esthetic changes. Preoperative impressions are taken, and a wax-up is performed. One of the key points in developing a proper wax-up is the evaluation of the emergence profile (figures 18 and 19). The use of this technique is particularly indicated in cases of a semi-additive approach in the gingival third (figure 20). The clinical evaluation and the cast analysis

could give the proper information about the possible modification of the emergence profile . The gingival third is modified to obtain a contour that could mimic the morphology of the gingival tissues and the natural light over the contoured crown of the natural tooth **(Kay, 1985)**.

Figures 18 and 19: The clinical examination and the cast analysis help the clinician to evaluate the emergence profile of the existing dentition. The lateral view of the central incisor allows the clinician to assess whether it is appropriate to increase the emergence profile.

Figure 20 : The wax-up is only additive, with care being taken to develop the contour of the gingival third so that it is as similar as possible in shape and volume to the gingival margin.

This approach has several advantages:

- Improves the emergence profile of the restoration, allowing a more natural appearance.

- Saves tooth structure, especially enamel in the cervical third.
- Reduces patient discomfort (if the final volume of the restoration allows a semi-additive approach, local anesthesia is unnecessary in most cases).

The wax-up is then transferred to the mouth using a silicone index (figure21), which is tested esthetically and functionally. This wax-up represents the enhanced natural dentition, is the cornerstone of the entire approach, and will provide critical guidelines such as the position and length of the maxillary incisors. In most cases, the additive wax-up allows for the maintenance of the preparation entirely, or at least in the majority of cases within enamel limiting the need for immediate dentin sealing (IDS) **(Magne and Douglas, 1999)**.

Moreover, besides restoring esthetics, the restorative treatment improves the function of the anterior guidance, which is tried immediately after the application of the mock-up. The mock-up should be tested for 1 to 2 weeks to ascertain the length and shape of the future restoration and ensure that there are no interferences with function, phonetics, and overall patient comfort. Once approved by the restorative team and the patient, the APT restoration is used as a precise guideline to prepare the tooth structure, based on the planned final tooth contours. The tooth structure will undergo only the most necessary and minimal preparation, or even no preparation in certain areas, using depth cutter burs through the APT restoration, according to the pre-established final contour **(Imburgia et al., 2019)**.

Figure 21 : Through a silicone index and bisacrylic resin, morphological changes can be transferred over the existing dentition.

In the following case, starting with round burs, the teeth were prepared to generate 0.3 mm (gingival third), 0.5 mm (middle third), and 0.8 mm (incisal third) calibration grooves (figures 22 to 30). The mock-up was removed from the teeth, and diamond burs were used for vertical preparation to remove the tooth substance between the depth cuts. The preparation was performed by using a 0.12-mm diamond bur for a featheredge margin. A retraction cord (000) was placed into the gingival sulcus to displace the gingival margin, and the margin was finished with a 30-µm diamond bur and silicone points. The final impression was taken with a polyether material, and the provisional restoration (in this case, necessary) was performed using a scalloped silicone index and bisacrylic composite resin **(Imburgia et al., 2016)**.

Figures 22,23, and 24 : The calibration grooves are made horizontally by ball diamond burs of various thicknesses through the mock-up. Once they are made, it is useful to highlight them with a pencil.

Figures 25,26, and 27 : The residues of the mock-up are removed and the tooth substance between the calibration grooves is removed, using a drill for a vertical preparation and taking care to change its inclination in the three thirds of the buccal surface.

Figures 28,29, and 30 : The preparations are finished and polished. After the impression taking, a direct temporary restoration is made using the same silicone index.

13. Laboratory procedure

The definitive cast was molded and the definitive wax-up performed following the initial project and the clinician's indications. The key point in the laboratory procedure is starting the wax-up of the gingival third before ditching the cast, so as to have the gingival tissues as point of reference **(Schwartz-Arad, 2019)**.

The difference between horizontal and vertical preparations is that in the former, the margin is positioned by the clinician and leaves a well-defined line on the tooth, which is then replicated in the impression and the working model **(Loi and Di Felice, 2013).**

In vertical preparations, the margin is positioned by the technician, based on the gingival tissue information. In most cases, the position of the finishing line is performed by the technician, taking as point of reference the cervical margin detected by the impression**(Ferrari Cagidiaco et al., 2021)**.

The emergence profile is developed following the profile of the gingival tissue. The final wax-up is pressed and sintered , and finishing and mechanical polishing were performed, always considering the maintenance of the planned emergence profile . The finished veneers were tried on the tooth preparation, and the translucency is checked through the try-in paste of the luting agent **(Patroni, 2020).**

Careful attention is paid to the cervical appearance and shade transition, The thickness of the veneers, once verified by an Iwanson gauge, is equal to

the volume of the planned prosthetic restoration .The emergence profile of the veneers must be checked carefully before starting with the luting procedure (figures 31 and 32). Following an adhesive protocol and the conditioning of the intaglio surfaces of the veneers, the restorations are luted **(O'Sullivan, 2019)**.

Figures 31 and 32 : The integration of the restoration profile must be verified on all restorations before starting with the conditioning of the inner surface of the veneers and their cementation

The finishing of the margin is performed using a cutting blade, scalers, and a diamond rubber point specifically for intraoral adjustment of high-strength ceramics. The same adjustment is carried out for the occlusal surface **(Edelhoff et al., 2018)**.

The clinical control of the emergence profile in different steps is the key point of this technique. The ideal situation is a semi-additive scenario in which the controlled preparation and the vertical finishing line allow for the preservation of the enamel in the cervical third, as well as an improvement of the relationship between the emergence profile and surrounding tissues (figure 33) , avoiding bulky veneer restorations **(Imburgia et al., 2016)**.

Figure 33 : Postoperative view: 1-year follow-up

14. Conclusions

Current research has confirmed that there is no single universal and recommended method in all cases type of tooth preparation for a prosthetic crown. The choice of a finish line depends on a number of factors, such as pulp vitality, location of the tooth, its inclination, type of material from which a restoration will be manufactured, crown convexity, patient's age, and size of such a construction **(Labno and Drobnik, 2020)**.

At the same time, it should be emphasized that in some clinical situations, such as abutment discoloration or insufficient amount of tooth structures visible after an old crown removal, the decision on the type of preparation and/or reconstruction to be made is taken intra-procedurally **(Meyenberg, 2013)**.

In spite of the intensive development of technology, both with reference to clinical tooth preparations for permanent restorations and to laboratory technologies, the range of indications for the application of vertical preparation is minor, and at present is limited to restorations made only of full-contour zirconium oxide. Due to the small number of clinical studies undertaken to assess the efficacy of this method of preparation, it is necessary to conduct further research studies and observations **(Powers and Wataha, 2014)**.

15. The marginal accuracy of zirconia crowns with two margin designs (feather edge and deep chamfer)

Minimum invasive dentistry is the concept of obtaining excellent esthetic results without letting down the preservation of the biological structures especially in the cervical area where as the distance of the pulp preparation is of prime importance to preserve the strength of the tooth and the vitality of the pulp and it is one of the main objectives of recent restorative dentistry. Vertical preparations could be a more conservative alternative to a horizontal preparation design (shoulder or chamfer) **(Nawafleh et al., 2016)**.

It was reported that a good marginal fit seems to be one of the most

important technical factors for the long-term success of any restoration. Because a big marginal opening allows plaque accumulation, gingival sulcular fluid flow, and bone loss, resulting in microleakage, recurrent caries, periodontal disease and a decrease in the longevity of the prosthetics restorations **(Sakrana, 2013)**.

The null hypothesis of a recent study was accepted as there was no significant difference in the marginal accuracy of single crowns constructed from Zirconia reinforced lithium silicate (Vita Suprinity) ceramics with two different marginal designs (feather edge or deep chamfer) before and after cementation under thermo-mechanical aging. Zirconia reinforced lithium silicate (Vita Suprinity) was selected in the study as it combines the advantages of glass ceramics as esthetics and bonding protocol with a relatively high ceramic strength from zirconia particles addition (8-12%). The zirconia particles added to reinforce the ceramic by crack interruption (flexural strength is approximately. 420 MPa) **(Elsaka and Elnaghy, 2016)**.

A feather edge marginal design was chosen as a test group because it was proposed that such vertical margins would offer the procedural advantages of easier impression making, even for multiple abutments, and enhanced marginal adaptation after cementation **(Schmitz et al., 2017).**

Furthermore a smaller gap will cause less extrusion of cement that would be in direct contact with highly sensitive gingival sulcus environment as proposed by **(Scutellà et al., 2017)**.

A deep chamfer finish line design 0.7mm was selected as a control group as suggested that chamfer finish line design aid in increased fracture resistance of ceramic restoration than shoulder one as the deep chamfer finish line produces an angled enamel cut that increases the enamel's susceptibility to etching and bonding, so we have a good bond between the restoration and the teeth which improves the resistance to fracture compared to the shoulder finish line **(Jalalian and Aletaha, 2011)**.

Since the deep chamfer marginal design provides more round angle

between the axial and gingival seat which will enable a more precise crown seat than with shoulder finish line (90°). Shoulder marginal design results in incomplete crown seat and raises the vertical marginal gap. Also it may be due to the accuracy of digital scanner detection that is being affected by differences in depth of the preparation which could be easily detected in deep chamfer marginal design as suggested by **(Al-Zubaidi and Al-Shamma, 2015)**.

With regard to the effect of margin design, it was found that deep *chamfer* margin design recorded statistically non-significant higher marginal gap mean value (27.20 ± 3.52 μm) than *feather edge* design (26.21 ± 1.49 μm).This could be attributed to the fact that the more the margin of the restoration ends with an acute angle, the shorter the distance between the tooth and the margin of the restoration **(Comlekoglu et al., 2009)**.

The results of the study were in agreement with **(Riad et al., 2017)** who found that the feather edge marginal design can be recommended for the teeth without sufficient dentin and remaining coronal structure to decrease the pulp inflammation risk.

Also these results are in agreement with **(Schmitz et al., 2017)** who found that for monolithic lithium disilicate, the clinical outcomes provided with the feather edge marginal design were similar to that provided with other marginal designs.

The results of the effect of the marginal design on the marginal accuracy were not in agreement with **(Comlekoglu et al., 2009)** who found that feather-edge marginal design provided the least marginal gap but the results were with statistically significance. Feather edge marginal design (68 ± 9) was significantly lower than those of the chamfer marginal design (128 ± 10). This disagreement might be due difference in sample size, ceramic material or testing conditions

The following conclusions were obtained from the recent study **(El Eneen et al., 2019).**

- Monolithic zirconia reinforced lithium silicate (Vita Suprinity) ceramic

crowns fabricated with feather edge margin design yielded comparable marginal accuracy as that obtained with deep chamfer margin design.

- Feather edge margin design could be a promising conservative alternative to deep chamfer margin design with regard to marginal accuracy, when it is used for construction of zirconia reinforced lithium silicate (Vita Suprinity) ceramic crowns.
- Cementation affects the marginal accuracy negatively with both tested margin designs (feather edge and deep chamfer).
- Marginal accuracy values for both marginal designs (feather edge and deep chamfer) are within the clinically accepted values.

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