



Vertical Edgeless Tooth Preparation-Review and Clinical Reports

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Abstract

Vertical tooth preparation technique is a product of 21st century introduced to promote periodontal health. Vertical tooth preparation is otherwise known as biologically oriented preparation technique (BOPT). BOPT includes multiple procedures like vertical tooth preparation, gingivage and placement of an interim prosthesis. Gingival recession, quite common with conventional tooth preparations, can be avoided. A short review on the evolution of vertical tooth preparation and two clinical reports where biologically oriented tooth preparation was successfully employed are included in this article. These materials have excellent properties and biocompatibility but still we need to explore whether they are potent enough to be called as sustainable and biocompatible materials.

Keywords: Biologically Oriented Preparation Technique [BOPT]; Vertical Edgeless Preparation [VEP]; Peri-Implant Tissue Health; Convergent Collar Implants; Shoulderless Abutments; Emergence Profile; Gingivage

Introduction

Tooth preparation employed in the fabrication of fixed prosthesis belongs to two categories viz. horizontal and vertical. The former design has a definite finish line like shoulder or chamfer and the latter employs no definable finish line. In order to avoid the gingival trauma, clinicians prefer to keep the horizontal finish lines equigingival or supra gingival. In vertical preparations, there are no finish lines incorporated but the terminal portion of the restorations are kept subgingival. In the past, vertical preparation was indicated for periodontally involved abutments while preparing fixed prostheses. Vertical preparation requires more clinical skills in comparison to horizontal preparations. Horizontal finish lines are created by the profile of the selected diamonds. In vertical preparations, flame shaped diamonds are used and the diamond is not expected to prepare a profile. In fact, the gradient between cementum and enamel is eliminated and the gradient is recreated by the prosthesis.

Health of the periodontium is a precondition when fixed prostheses are fabricated. However, loss of periodontal attachment is not considered as a contra indication for the preparation of full coverage restorations. Tooth preparation has to be logically modi-

fied to allow the periodontal tissues to heal while the full crown is in position. Vertical Edgeless Preparation (VEP) was developed to suit the loss of periodontal attachment and it extends sub gingivally without making any morphological distinction. A group of dentists and dental technicians of Italy, designated as 'Porta Mascarella group' initiated this design of tooth preparation. VEP technique makes the termination very thin and ensures maximum closure towards the tooth surface. This technique is considered as an extension of the classic feather edge gingival termination but VEP makes no distinct transition between the prepared and unprepared tooth surface. Tooth restoration transition is so smooth and makes no interference to the periodontal tissue healing and regrowth [1,2].

Vertical edgeless preparation (VEP)

Root surface that has lost periodontal attachment consists of necrotic cement and dentin which harbours microorganisms capable of producing toxins. VEP eliminates the unhealthy tissues and the restoration protects the root from the oral environment. This preparation is originally restricted to teeth which have lost periodontal attachment but not indicated on teeth with active periodontitis. VEP is more appropriate in patients with thick periodontal phenotype and probing depth greater than 2 mm. The subgingival crown margin will be well covered by the healed gingiva [3-5].

Tooth preparation for VEP

The first step in the preparation is evaluation of the gingival sulcus depth with a periodontal probe. The sulcus is further verified with 862 Flame diamond bur (Komet or Meisinger). Coronal portion of the tooth is prepared first to create the required restorative space. A flame shaped diamond is used to prepare the subgingival portion keeping only the tip in contact with the tooth surface. For this purpose, the axis of the bur is tilted 30° away from the surface. The bur is kept short of the gingival sulcus previously ascertained. With this preparation, along with the root surface, inner surface of the gingival sulcus will also be removed. The axial wall is further refined to avoid the gradient on the tooth surface. The gingivage provides augmented space and the operator gets access to the deepest portion of the sulcus. This also helps in the removal of contaminated hard and soft tissues. The reach of the bur tip may not correspond with the termination of the restoration fabricated. The margin of the provisional crown is kept short of the sulcus so that the healing will progress undisturbed. (Figure 1-3). The cross sectional shape of the margin of the crown is triangular and very thin. It avoids over contouring and thereby prevents plaque accumulation. Zirconia and Lithium disilicate are materials of choice used for this purpose [6].



Figure 1: Tooth preparation and gingivage.



Figure 2: Provisional restoration placed.



Figure 3: Healed gingival tissue.

Biologically oriented preparation

Ignazio Loi and Antonello De Felice proposed a Biologically oriented preparation technique (BOPT) suited for patients with healthy periodontium. This was an attempt to control the complication of apical migration of the gingival margin. The possible reasons for the gingival migration have been identified as follows: thin gingival bio type, inadequate keratinised mucosa, trauma caused by the tooth preparation, poor marginal adaptation of the restoration and inadequate oral hygiene measures [7].

The tooth preparation for BOPT

Incisors

- Proximal surfaces are prepared by coarse flame shaped diamond points (FG862/010C) (Figure 4.1, 4.2)
- 2mm incisal reduction with the same diamond is done, until the enamel and dentin are clearly identified. (Figure 5.1, 5.2)
- Labial surface is prepared with 45° inclination until the enamel-dentin junction is reached. The bur used is FG 862 G/016C. (Figure 6.1)
- Labial and palatal axial walls are prepared with FG862G/012C. All the axial walls are circumferentially merged but restricted to supragingival area. (Figure 7.1, 7.2)
- The diamond used in the previous stage is used to enter the gingival sulcus obliquely (30°) and gradually verticalized to merge with the prepared axial walls. Care should be taken not to make any indentation on the tooth surface to ensure soft tissue adaptation to the prepared tooth surface. Gingivage is done in this stage (Figure 8.1-8.3)
- Palatal reduction is done with football shaped diamond-FG 868C/023C (Figure 9.1)
- The prepared tooth surfaces are finished with red coded diamonds of flame shape. If more finish is required yellow coded diamond can also be used. (Figure 10.1-10.3) [8,9]



Figure 4.1: Proximal contact breaking.



Figure 7.1: Labial reduction.



Figure 4.2: Proximal surface preparation.



Figure 7.2: Reduction of the cingulum area.



Figure 5.1: Incisal reduction.



Figure 8.1: Oblique entry into gingival sulcus area.



Figure 5.2: Incisal reduction completed.



Figure 8.2: Straightening of the diamond.



Figure 6.1: Labial reduction upto dentino enamel junction.



Figure 8.3: Merging the axial walls.



Figure 9.1: Reduction of the palatal concavity.



Figure 10.1: Finishing the axial surface.



Figure 10.2: Finishing the palatal concavity.



Figure 10.3: Completely finished incisor preparation

Molars

- Proximal contacts are removed and the surfaces are prepared with coarse grit thin flame diamond (FG862/010C) (Figure 11.1, 11.2)
- Occlusal surface is prepared with round ended tapered diamond (FG856/018) (Figure 12.1, 12.2)
- Occlusal third of the buccal and lingual surfaces are prepared with coarse diamond (FG862G/016C) until the enamel dentine junction is reached. Bucco lingual dimension of the occlusal table will get reduced by this step. (Figure 13.1)

- Buccal and lingual walls are reduced and all the axial walls are merged. The reduction is restricted to supra gingival areas (FG862G/016C). (Figure 14.1, 14.2)
- Intrasulcular preparation is done similar to that of the anterior. Flame shaped diamond (FG862C/012C or FG862C/016C) is used to enter the sulcus obliquely and then gradually verticalized to align with the axial wall. The gingivage will happen in this stage. (Figure 15.1, 15.2)
- The prepared tooth surface is finished with red/yellow ringed smooth surfaced diamond (Figure 16.1, 16.2) [8,9].



Figure 11.1: Proximal contact removal.



Figure 11.2: Proximal surface preparation.



Figure 12.1: Occlusal reduction.



Figure 12.2: Completed occlusal surface reduction.



Figure 13.1: Occlusal third reduction of buccal and lingual surfaces.



Figure 14.1: Completed buccal and lingual walls.



Figure 14.2: Axial walls merged.



Figure 15.1: Oblique entry into the gingival sulcus.



Figure 15.2: Straightening of the flame diamond.



Figure 16.1: Finishing the tooth preparation.



Figure 16.2: Completed molar preparation.

Provisional restoration

The preferred technique of fabrication of provisional crown in BOPT is indirect-direct method in which an under preparation is done on a cast and a tooth-coloured self cure shell crown is prepared over it. After checking the seating in the mouth, the shell crown is relined with Bis-GMA resin (Protemp). The fine subgingival extension will be obtained in the provisional crown. It will also copy the existing gingival border and appropriate modifications can be made by trimming the border or by addition of the resin. Border of the crown is kept short of the sulcus depth so that the area that has undergone gingivitis can heal undisturbed recreating the attachment. (Figure 2,3). Instead of the shell crown, poly carbonate prefabricated shell crown can also be used. Four to twelve weeks of healing period is recommended with the interim restoration in position.

Impression

Once the healing is completed, elastomeric impression can be made using any of the accepted method. Gentle gingival retraction is recommended.

Definitive restoration

Definitive restorations can be made with monolithic zirconia or monolithic lithium di silicate using CAD/CAM. Conventionally when shoulder and chamfer preparations were adopted, discrepancies in the border in the range of 50 to 75µm was observed though it is within the clinically acceptable range. In vertical preparations such a discrepancy is not expected and that is the superiority of the technique [10].

Clinical Report -1

Sixty year-old male patient with good health and no contra indication for oral surgery, reported for restoring 21 which had El-

lis Class II fracture. The tooth was root canal treated when the it has turned non vital. The gingival biotype was thick (Figure 17). It was decided to restore the tooth with a zirconia crown and to prepare the tooth opting biologically oriented preparation technique (BOPT). The fractured portion was restored with composite resin and a putty index was prepared to make the provisional restoration. The tooth preparation was done as described in the previous section. The finish line was extended to the gingival sulcus using a flame shaped diamond bur (Figure 18,19). This created blood clot at the apical level of the preparation (Figure 20). After finishing the tooth preparation, the interim restoration fabricated with pro temp was relined and adapted (Figure 21). The borders were trimmed and the sulcular extension of the interim restoration was made short of the sulcus depth by 0.5 to 1 mm and cemented (Figure 22,23). After 8 weeks, the interim restorations were removed. The soft tissues healed and gingival cuff was formed around the prepared tooth (Figure 24). Two step elastomeric impression was made using light body and putty (Ivoclar Vivadent AG). Zirconia crown was fabricated using CAD/CAM and was cemented with dual polymerizing resin cement (RelyX 3M ESPE) (Figure 25). Follow-up evaluations were made at 3rd and 6th months after the placement of the definitive prosthesis (Figure 26).



Figure 19: Flame shaped bur used for extending the preparation to the gingival sulcus.



Figure 20: Blood clot in the sulcus.



Figure 17: Fractured incisor.



Figure 21: Relining of the interim restoration.



Figure 18: Axial wall preparation.

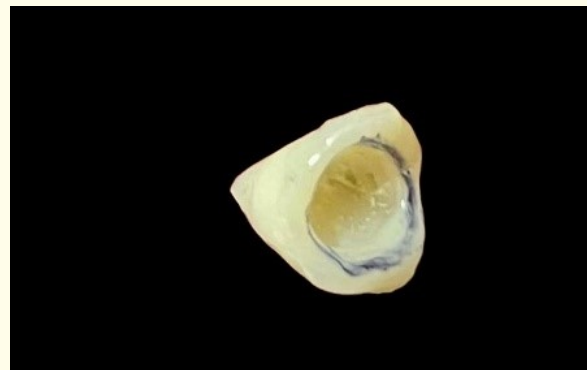


Figure 22: Sulcular portion of the relined provisional is marked.



Figure 23: Finished interim restoration.



Figure 24: Healed gingival cuff.

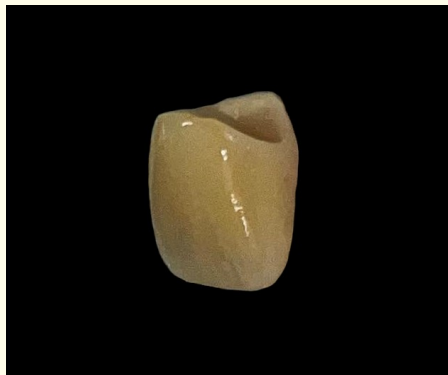


Figure 25: Finished Zirconia crown.



Figure 26: Restored incisor.

Clinical report -2

Thirty year old female patient with good health and no contra indication for undergoing surgical procedures, reported for the treatment of 25 which was endo treated and was discoloured. It was decided to fabricate an all ceramic (Zirconia) crown and BOPT tooth preparation was planned. The gingiva was of thick biotype. All the steps described above were followed viz. Conventional occlusal and axial wall preparation with round ended diamond, preparation of the tooth into the sulcular area and gingivage with flame shaped diamond, relining the interim restoration and its border modification to thin geometry, waiting for 8 weeks, evaluation of gingival cuff for healing, elastomeric impression and CAD/CAM zirconia crown cementation were done (Figure 27-33).



Figure 27: Endo treated and discoloured maxillary second premolar.



Figure 28: Occlusal reduction.



Figure 29: Gingival sulcular preparation.



Figure 30: Prepared tooth and blood clot.



Figure 31: Interim restoration.



Figure 32: Healed gingival cuff.



Figure 33: Zirconia restoration on 25.

Discussion

Crowns were prepared in the early history with gold shell shaped crowns where definite tooth reduction was done or not is a questionable issue. Teeth might have been prepared with feather edge or chisel edge. Once casting technology was invented, shoulder and chamfer preparations have become the gold standard. This has resulted in considerable tooth material loss and subsequent pulpal damage. On experimental typodont teeth, the tooth material loss was calculated to be 60 to 70 percent when shoulder was prepared. When laminate preparations were done, the tooth material loss was between 3 to 30 percent [11,12].

Conventional crown preparations also had aesthetic loss caused due to gingival recession which is minimal in feather edge preparation. Thus, clinicians have thought of eliminating the gingival recession by adopting vertical tooth preparation. This was originally developed to create space for impression material and named as 'rotary gingival curettage'. The following names - Vick Pollard, Rex Ingraham, Di Febo, and Carnevale were related to the development of this technique. In 2013, Ignazio Loi and Di Felice have formalised the technique by designating it as 'biologically oriented preparation technique' (BOPT) [8].

The advantages of BOPT are: tooth hard tissue loss is minimised, thin margin ensures good seal, inflammation to the pulp is reduced because temperature rise is considerably controlled during tooth preparation and thereby future endodontic treatment needs are eliminated, gingival bio type gets thickened and reasonably good retention. Certain disadvantages are also noticed. Tooth preparation is highly demanding because of the gingival sulcular involvement. It is very difficult to remove the excess luting cement from the gingival sulcus. It is also difficult to evaluate the marginal fit of the restoration [13,14].

Superior strength of zirconia makes it the right choice for restoring the crowns in vertical preparations. In short crowns, if vertical preparation is opted, because of the parallelism of the axial walls, retention can be ensured. In mandibular incisors, vertical preparation is the right choice because a shoulder can cause heavy structural loss of the tooth [10].

BOPT and dental implant treatment

BOPT has recently been applied to dental implant treatment. The implant has a machined titanium prosthetic platform, conical in shape, 2.8mm in height, tapering in the occlusal direction without finish line. These are named as convergent collar implants (PRAMA implants-Sweden and Martina). When the abutment is placed, it forms a vertical plane without any horizontal gap. The cemented restorations can reach, as in the case of vertically prepared tooth 1mm apical to the peri implant gingival margin.

Implant treatment success, to a great extent is evaluated by the changes happening in the marginal bone level. Contamination with microorganisms occurring at the junction of the implant and abutment is considered as the reason for bone level changes. Tissue level implants are found to avoid this complication. Divergent collar which is common with tissue level implants, compresses the soft tissue and causes gingival recession. It is observed that implants with convergent transmucosal component, relieves the compression and improves stability of the tissues. After the placement of implant, the healing occurs by secondary intention and myofibroblasts play a key role in establishing the biologic width. The coronal convergence helps the tissues to migrate coronally and along with that it gets thickened or in other words the volume increases. The collar has a combed micro roughness which favours adhesion of fibroblasts to the titanium surface and improves the tissue seal [15,16] (Figure 34)



Figure 34: Implants with converged collar.

Convergent collar and matching abutment enable the clinician to place the border of the restoration slightly over to the implant with the help of making appropriate interim restorations (Figure 35). Just like in natural teeth where BOPT is employed; with implants also the gingival architecture can be modified along with the emergence profile. The restoration border effectively covers the implant abutment junction and prevents gingival recession due to harbouring of microorganisms [17,18].



Figure 35: Crown margin extends apical to implant abutment junction.

Vertical preparations have come to stay in the field of dentistry. But more clarity is required on the gingival termination fabrication and its extend. Long term observations on the gingival architecture are also not available. It will be relevant to conduct long term comparative studies on BOPT.

Conclusions

Biologically oriented tooth preparation technique is comparatively a recently introduced clinical method. The main objective of this technique is to control the probable gingival recession seen with majority of restored teeth using conventional horizontal preparation. The gingival extension in BOPT is governed by vague parameters unlike in horizontal preparations where terminations have definite geometry. Getting more evidence on the success of BOPT in implants as well as in teeth is essential to determine the long term predictability of the treatment. At present only zirconia crowns are used in association with BOPT. The spectrum of materials used should also be broadened.

Author Contributions

Conceptualization-Pradeep Dathan; *Clinical report*-Aswathy S Kumar, Lekshmy A R; *Review of articles*-K. Chandrasekharan Nair, Aswathy S Kumar; Pradeep Dathan, Lekshmy A R; *Initial draft preparation*-Aswathy S Kumar, Lekshmy A R; *Review and editing*-K. Chandrasekharan Nair; *Supervision*-Pradeep Dathan, K. Chandrasekharan Nair.

All authors have read and agreed to the published version of the manuscript.

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Figure credits

Fig 4 -16. Loi I. BOPT technique, Sweden and Martina preparation drill catalogue

Fig 34. <https://www.prama.sweden-martina.com/?lang=en>