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VERTICAL PREPARATION TECHNIQUE IN PROSTHODONTICS: BIOLOGICAL PRINCIPLES AND CLINICAL EFFECTIVENESS

Rakhimov Tavakkal Shuxratovich
Asia International university
traximov770@gmail.com
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Abstract.
The vertical preparation technique has gained increasing attention in contemporary prosthodontics because of its conservative approach, favorable periodontal response, and high esthetic potential. Unlike traditional horizontal finish-line preparations, vertical preparation does not create a clearly defined cervical margin. Instead, the preparation extends vertically into the gingival sulcus, allowing the restoration to shape the soft tissues naturally during healing and provisionalization. This concept became especially popular after the development of the biologically oriented preparation technique (BOPT), which emphasizes the interaction between prosthetic contours and periodontal adaptation.

The purpose of this article is to review the biological rationale, clinical stages, indications, advantages, and limitations of vertical tooth preparation. The article also analyzes its influence on gingival stability, emergence profile formation, and long-term prosthetic success. Current evidence demonstrates that vertical preparation may improve soft tissue esthetics and preserve periodontal health when performed correctly. However, the method requires advanced clinical skills, careful provisionalization, and close communication between clinician and dental technician.

Keywords: vertical preparation, feather-edge preparation, BOPT, prosthodontics, periodontal adaptation, emergence profile, crown preparation, fixed prosthodontics, esthetic dentistry

Introduction. Successful prosthodontic treatment depends not only on the quality of restorative materials but also on the design of tooth preparation. For many years, horizontal finish lines such as shoulder and chamfer preparations have been considered the standard approach for full-coverage restorations. These designs provide a distinct cervical margin and simplify laboratory procedures. Nevertheless, conventional horizontal preparations often require significant removal of healthy tooth structure and may negatively influence periodontal tissues if restorative margins are improperly positioned.

In recent years, clinicians have shown renewed interest in vertical preparation techniques because of their minimally invasive character and improved esthetic outcomes. Vertical preparation, also known as feather-edge preparation, eliminates the horizontal finish line and creates a smooth transition between the tooth and restoration. This approach allows the prosthetic crown to guide gingival healing and form a natural emergence profile.

The development of the biologically oriented preparation technique introduced a new philosophy in restorative dentistry. According to this concept, periodontal tissues are capable of adapting to prosthetic contours when provisional restorations are designed correctly. As a result, clinicians can influence gingival architecture without surgical intervention.

Today, vertical preparation is increasingly used in esthetic dentistry, implant prosthodontics, and full-mouth rehabilitation. Despite its growing popularity, the technique remains controversial among some practitioners because of its technical sensitivity and the difficulty of identifying restoration margins.

The aim of this article is to discuss the biological basis, clinical protocol, advantages, disadvantages, and clinical applications of vertical preparation in modern prosthodontics.

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Materials and Methods

This article is based on an analysis of scientific publications related to vertical tooth preparation and biologically oriented preparation techniques. Literature from prosthodontic, restorative, and periodontal journals was reviewed to evaluate the clinical effectiveness and biological impact of this approach.

The review included:

- Clinical studies
- Narrative reviews
- Case reports
- Prosthodontic textbooks
- Articles related to periodontal tissue response and emergence profile management

The collected data were analyzed and organized according to the following topics:

1. Biological principles of vertical preparation
2. Clinical protocol and instrumentation
3. Periodontal response
4. Esthetic outcomes
5. Advantages and disadvantages
6. Indications and contraindications
7. Long-term clinical considerations

Biological Concept of Vertical Preparation

The main difference between vertical and horizontal preparation lies in the absence of a clearly defined cervical finish line. In conventional preparations, the restoration ends at a shoulder or chamfer margin. In vertical preparation, the axial wall gradually narrows toward the gingival sulcus without creating a sharp edge.

This design allows the prosthetic crown to determine the final contour of the gingival tissues. During tooth preparation, slight intrasulcular rotary curettage is performed using diamond burs. This procedure removes the sulcular epithelium and creates conditions for controlled soft tissue healing around the provisional restoration.

The biologically oriented preparation technique is based on several important principles:

- Preservation of periodontal tissues
- Minimal removal of tooth structure
- Gingival adaptation to prosthetic contours
- Formation of a natural emergence profile
- Improvement of gingival thickness and stability

The provisional crown becomes a key factor in tissue remodeling. Properly shaped provisional restorations support the gingiva and guide healing. Over time, the soft tissues adapt to the cervical contour of the restoration, resulting in improved esthetics and gingival harmony.

Clinical Procedure

Tooth Preparation

Vertical preparation is usually performed using tapered diamond burs with fine or medium grit. The clinician reduces the axial walls while maintaining smooth convergence toward the gingival area.

The procedure generally includes:

1. Occlusal or incisal reduction
2. Axial reduction
3. Intrasulcular vertical preparation
4. Rotary curettage of sulcular epithelium
5. Fabrication of provisional restoration

Unlike shoulder preparations, no definite finish line is created. The preparation extends slightly into the gingival sulcus while respecting the biological width.

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Provisionalization

Provisional restorations are essential for the success of vertical preparation. They are responsible for shaping and stabilizing the gingival tissues during healing.

An ideal provisional crown should have:

- Smooth cervical contours
- Proper emergence profile
- Good marginal adaptation
- Adequate support for soft tissues

The maturation of gingival tissues usually requires several weeks. During this period, periodontal tissues adapt to the new prosthetic contour.

Final Restoration

After stabilization of soft tissues, definitive impressions or digital scans are obtained. Modern CAD/CAM technologies have improved the precision of restorations fabricated for vertically prepared teeth.

Common restorative materials include:

- Zirconia
- Lithium disilicate ceramics
- Metal-ceramic crowns
- Monolithic ceramic restorations

The final crown must accurately reproduce the emergence profile created during provisionalization.

Indications

Vertical preparation can be recommended in the following situations:

- Esthetic rehabilitation of anterior teeth
- Thin gingival biotype
- Correction of gingival asymmetry
- Replacement of old crowns with subgingival margins
- Cases requiring minimal cervical reduction
- Full-mouth rehabilitation with periodontal optimization

The technique is particularly valuable in patients where soft tissue esthetics play a major role.

Contraindications

Despite its benefits, vertical preparation is not appropriate for every patient.

Contraindications include:

- Active periodontal disease
- Poor oral hygiene
- Short clinical crowns
- High caries activity
- Inadequate clinician experience
- Patients with poor compliance

Incorrect execution of the technique may lead to plaque accumulation, gingival inflammation, or overcontoured restorations.

Advantages of Vertical Preparation

One of the main advantages of vertical preparation is preservation of tooth structure. Since no shoulder is created, less cervical dentin is removed. This contributes to a more conservative treatment approach.

Another important advantage is improved periodontal adaptation. Clinical studies report increased gingival thickness and stable gingival margins after treatment with BOPT principles.

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The technique also offers significant esthetic benefits. The clinician can modify the emergence profile and improve soft tissue symmetry without surgical procedures. This is especially important in the anterior region.

Vertical preparation may also improve stress distribution in ceramic restorations and reduce the risk of fracture in some clinical situations.

Finally, many clinicians report excellent long-term soft tissue stability and patient satisfaction.

Limitations and Challenges

Although vertical preparation provides multiple advantages, the technique remains highly sensitive and technically demanding.

One of the major challenges is the absence of a clearly visible finish line. This may complicate impression taking, digital scanning, and laboratory communication.

Another limitation is the risk of overcontouring. If the emergence profile is excessively convex, plaque accumulation and chronic inflammation may develop.

The technique also requires careful provisionalization. Poorly fabricated temporary crowns can compromise gingival healing and negatively affect the final result.

Additionally, dental technicians must possess adequate experience in managing restorations without a defined margin.

Discussion

Modern restorative dentistry increasingly focuses on minimally invasive and biologically compatible treatment methods. Vertical preparation reflects this trend by combining conservative tooth reduction with periodontal tissue management.

The introduction of BOPT changed the traditional understanding of prosthetic margins. Instead of forcing soft tissues to adapt to a rigid finish line, the clinician allows the gingiva to heal naturally around the restoration.

Clinical evidence suggests that vertical preparation can produce highly esthetic and stable outcomes when appropriate protocols are followed. Nevertheless, treatment success depends greatly on the clinician's knowledge of periodontal anatomy and prosthetic design.

Digital dentistry may further improve the predictability of this technique. Intraoral scanners, CAD/CAM systems, and high-strength ceramics simplify restoration fabrication and enhance marginal precision.

Despite promising results, additional long-term randomized clinical studies are necessary to compare vertical preparation with traditional horizontal finish-line techniques.

Conclusion

Vertical preparation is an important contemporary approach in prosthodontics that combines minimally invasive tooth reduction with biologically guided soft tissue management. The technique allows clinicians to improve emergence profiles, preserve periodontal tissues, and achieve highly esthetic restorations.

When performed correctly, vertical preparation may provide excellent gingival stability, natural soft tissue contours, and long-term restorative success. However, the method requires advanced clinical skills, precise provisionalization, and careful case selection.

The growing popularity of biologically oriented preparation techniques demonstrates the increasing importance of periodontal considerations in restorative dentistry. With further clinical research and technological development, vertical preparation is likely to become an even more significant component of modern prosthodontic treatment.

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