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Review Article

Teeth Preparation in Crown and Bridge

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Abstract

Introduction: In teeth preparation, the form of prepared teeth and the amount of tooth structure plays an important role in the biological, mechanical, and aesthetic properties of a fixed partial denture or overlying crown. Proper steps in preparation and clinical guidelines are important for the success of these prostheses. But most often, it is difficult to a predictable result for dental students and young clinicians. The inappropriate techniques may lead to failure of prosthesis and loss of tooth structure as well. Unlike other tissues, dental tissues do not possess regenerative capacity, so the removal of dental tissue should be planned very well prior to starting teeth preparation and executed in a good manner. The purpose of a fixed prosthodontic therapy largely varies from the as small procedure as single-tooth restoration to a full mouth rehabilitation to establish a proper complete. A single tooth can be easily and fully restored to its optimum functional and aesthetic quality. A missing tooth in the dental arch can be replaced using a fixed prosthesis to increase masticatory competence in order to maintain or improve dental arch functions as well as elevate the patient's confidence and self-image. Planning is of utmost importance since mutilations of teeth can fracture of teeth by excessive cutting away of tooth structure for gaining access in endodontic treatment. Therefore, the teeth must be restored to a suitable form, and dental caries must be controlled using an appropriate treatment and treatment plan.

Aim of the Study: The purpose of this study is to understand tooth preparation, the steps and technique involved, as well as basic fundamental principles.

Methodology: The review is a comprehensive research of PUBMED since the year 1961 - 2015.

Conclusion: For a successful and predictable prosthodontic treatment, tooth preparation must be based on fundamental principles. These principles are divided into the preservation of tooth structure and periodontium, marginal integrity, structural durability, retention and resistance form, and aesthetic consideration. During tooth preparation, improvement in one area often affects another area and may lead to the failure of another. Careful attention to every detail is mandatory and depends on various factors such as type of restoration, luting agents used, retention and resistance form, the position of the margins, optimal aesthetic requirement, and tooth alignment. Thus, the clinician should be meticulous with their preparation, impression, provisionalization and Cementation of the final prosthesis.

Keywords: *Guidelines of Tooth Preparation; Steps in Tooth Preparation*

Basic principle for teeth preparation

Tooth preservation

All the care must be taken to preserve the health of oral tissue. During tooth preparation, the adjacent teeth, pulp of the tooth being prepared, soft tissues can be easily damaged [1].

Protection of adjacent teeth

The iatrogenic damage to the adjacent tooth is one error that commonly occurs in dental practice. The tooth preparation technique must be in a way to avoid and prevent damage to the adjacent tooth. The use of a matrix band or the proximal lip of enamel made during preparation can be useful in the protection of the adjacent tooth [1,2].

The damage to the proximal contact area of adjacent teeth makes it more susceptible to dental caries despite reshaping and polishing in comparison to the intact tooth surface. This is possible because of the high fluoride concentration in intact undamaged tooth structure and the less susceptibility of plaque retention at smooth surfaces of teeth [2].

Pulp protection

Degeneration of pulp can occur several years after tooth preparation. Chemical irritation, extreme temperature, and microorganisms may cause irreversible pulpitis, especially when they occur on freshly sectioned dentinal tubules [2].

Minimizing heat production during preparation

During the preparation of the tooth, in the cutting process, the energy used is mostly transformed into heat, which depends on cutting time and rate, the pressure applied, cooling technique, type of bur-diamond or carbide, the speed and torque of the rotary instrument used during preparation. Since the pulpal damage is evident because of the above-mentioned causes, it is essential to select techniques and materials that can reduce the risk of damage to the pulp [2,3].

The high pressure and speed used by the handpiece may cause the rise of intra-pulpal temperature. On doubling the speed of rotating bur and pressure applied to the handpiece can increase the temperature by 50%. It is seen that most of the clinician, while teeth preparation for fixed restorations, operate handpiece at high-speed as well as apply a force which may vary from 50 to 150 g/cm^2, but ideally, the cutting force of 100 g/cm^2 is considered optimal when medium-grit diamond burs are used. The torque of the handpiece also plays an important role and effect on the cutting force since the handpiece with higher torque requires a cutting force of 1.44 in comparison to the lower torque handpiece that only requires a force of 1.2N [4,5].

The most important concern with cutting with ultra-high-speed handpiece (200,000 - 400,000 RPM) is the rise in temperature by heat generated due to friction, which causes outward flow of dentinal fluid and is thermal expansion; therefore, appropriate cooling must be used during high-speed to diminish this outward flow. Cutting dry causes an inward flow of dentinal fluid, causing sharp pain, which is stimulated by A-delta neurons [6].

The intra-pulpal temperature can be decreased by directing water spray at the area of contact between tooth and bur; this also removes debris since the collection of debris causes clogging of the bur, which in turn reduces its cutting efficiency. This method also prevents the desiccation of dentin. Reducing pulpal damage is essential for the longevity of treatment, which can be achieved by having adequate patient chair time and using copious water spray, feather-light touch while tooth preparation, and using new burs, and avoiding "bur drag" [3].

Chemical irritation

The chemical components of certain luting cement may cause pulpal damage, especially when used on a freshly cut tooth. To avoid this, the application of cavity varnish and dentin bonding agents is useful as it acts as an effective barrier; however, their effect on the retention of the cemented crown is controversial [7].

Bacterial action

Removal of any carious lesion prior to making impressions for the restoration of utmost importance because any residual traces of infection at the site of restoration affect the success of the restoration. The access of bacteria to dentin can cause pulpal damage because of microleakage. The highest antibacterial activity among luting cement was found for zinc phosphate, followed by polycarboxylate cement and glass ionomer cement. Dentine bonding agent should be applied prior to making an impression so as to provide immediate protection against bacterial leakage and sensitivity. This not only improves patient comfort but also helps in the conservation of tissues [8,9].

Conservation of tooth structure

It is mandatory to conserve as much tooth structure as possible while tooth preparation. The remaining dentin thickness (RDT) is inversely proportional to the pulpal response, so the unnecessary extension of the tooth preparation in close proximity to the pulp must be avoided, the occlusal anatomy should be followed during occlusal reduction and produce minimum taper, and it should be in a way to allow patient to maintain good oral hygiene [9].

Intra-crevicular margins

The success of the restoration depends on the placement of the finish line, which is placed in enamel and supragingival whenever possible, since subgingival margins may cause periodontitis. The intra-crevicular margin should not be placed deeper than 0.5 - 0.7 mm. All the margins should ideally be as smooth as possible, easily duplicated in the impression and on the die in order to produce a good fit of the restoration. The fracture toughness of dentin-enamel junction is 5 - 10 times greater than the enamel but lower than dentin. Any disharmonious mechanical disruption to supra-crestal gingival attachment is reversible as long as the biological width is not invaded by restoration. If gingival fibers and junctional epithelium are not disturbed, then the level of the alveolar crest and gingival margin level remains stable. The assessment of periodontal pocket depth can be done by inserting a periodontal probe in an apical direction to the axis of the tooth between the tooth surface and gingival surface. The probing depth in posterior teeth is up to 2 mm and in anterior teeth can be up to 1mm; in this way, it is easy to violate the biological width during crown preparation in anterior teeth. To prevent apical migration of gingiva, a buffer zone must exist between the finish line of the prepared tooth and the bottom of the gingival crevice, which can be achieved by pre packing the gingival sulcus with non-impregnated cords. End cutting burs are used to relocate the margin sub-gingivally in order to prevent injury to the gingival sulcus [10,11].

Mechanical consideration

Mechanical considerations include factors such as the integrity and durability of the restoration and include resistance form, retention form, and deformation [12].

Structural durability

To withstand the occlusal forces without distortion, a restoration must have adequate bulk of the material, which should be within the natural confines of the tooth being prepared to avoid any periodontal disharmony. For a metal crown, occlusal clearance of 1.5 mm on the functional cusp and 0.7 - 1 mm on a nonfunctional cusp is required. For all-ceramic restorations, occlusal clearance of 2 mm is needed. The

functional bevel on the cusp plays an integral part in the occlusal reduction step. Adequate bulk of metal is needed on the functional cusp, it being an area of heavy occlusal loads. All the line angles of the prepared tooth should be rounded off to avoid stress concentration [12].

Resistance and retention form

In a tooth preparation, the more parallel the opposing walls are, the greater the would be retention and the more conservative is the tooth preparation. But achieving parallel walls under all clinical conditions is difficult without the risk of producing undercuts in the tooth preparation. Recently, the determining factor in a crown's resistance to dislodgement has been advocated by resistance to lateral forces and not retention along the path of insertion [12].

Total occlusal convergence (TOC)

An occlusal convergence (TOC) of 2 - 6° taper is ideal in tooth preparation. However, this ideal taper is routinely not achieved, and more taper is given. A tapered diamond bur can give a taper off of 2 - 3° to a tooth surface. It cuts if the shank of the instrument is held parallel to the intended path of insertion of the preparation, that is, the long axis of the tooth. The best clinical way to observe TOC is by visualizing the preparation in a mirror rather than looking occlusally. Reduction in cervical TOC is proven to be more effective than proximal grooves to enhance the resistance form. A clinician should give a TOC of more than 20° in a situation where crown height is adequate. In the inadequate height of crown TOC < 20° should be planned along with auxiliary retentive features in tooth preparation or on the internal surface of the crown to provide better retention. It is important to evaluate total occlusal convergence angles on various teeth [12,13].

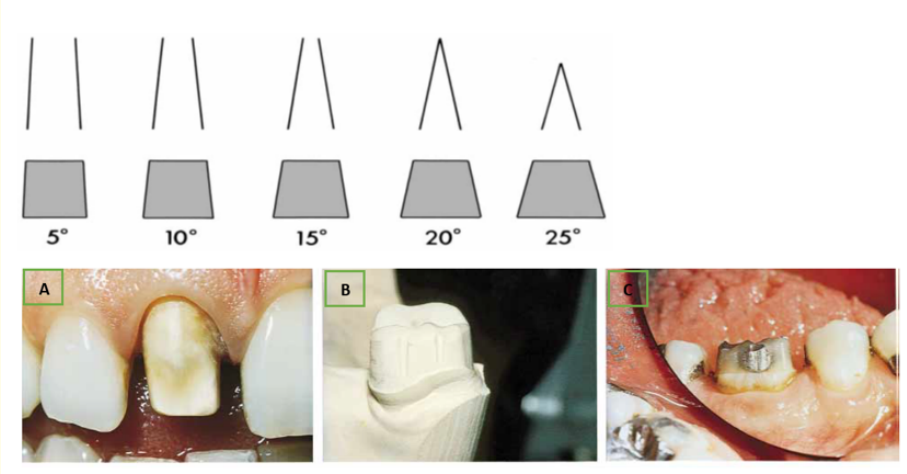

Figure 1: *Showing vertical lines representing total occlusal convergence (TOC) of axial walls when prepared with 5-, 10-, 15-, 20-, and 25-degree TOC. Figure (A) showing a facial view of the maxillary central incisor prepared for an all-ceramic crown. TOC between mesial and distal walls is 5 degrees. (B) The cast of the mandibular molar prepared with 7 degrees of TOC on posterior teeth. (C) Facial view of a mandibular molar with 18 degrees of TOC [13].*

Occluso-cervical/inciso-cervical dimension

The anterior teeth and premolars should have a minimal occlusocervical (OC) dimension of 3 mm and that molar of 4 mm. Some critical convergence angles have been identified, angles beyond which a prosthesis would not possess enough resistance to dislodgment

theoretically. An adequate resistance molar resistance in molars is seen when the tooth possesses OC dimension of 3 mm and TOC of 17 degrees or less. But, achieving 17 degrees is unlikely to occur on molars; in routine practices, this makes 3 mm an inadequate OC dimension for molar tooth preparations. Therefore, 4 mm is the recommended minimal OC dimension for molars. The minimal dimensions can be measured with a periodontal probe in prepared teeth [14].

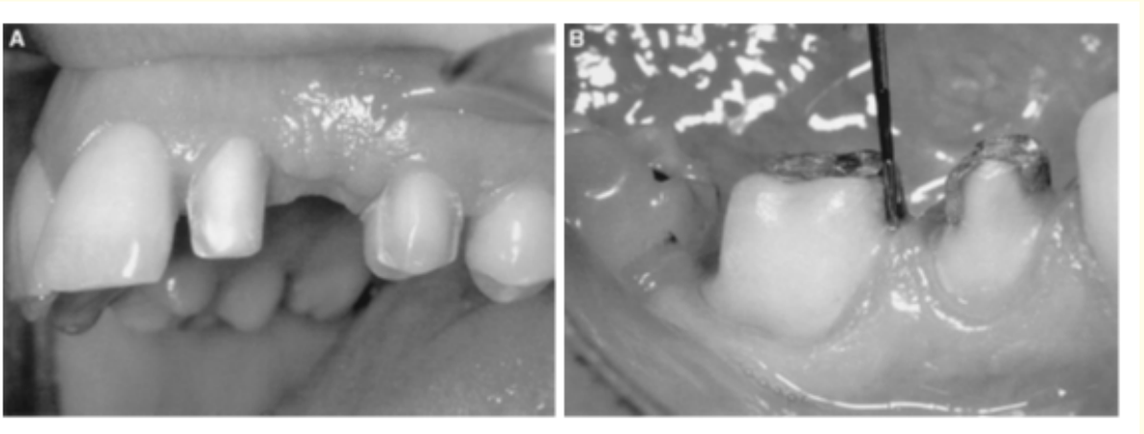

Figure 2: *Showing (A) The maxillary premolar has the minimal recommended OC dimension of 3 mm for anterior teeth and premolars. (B) The OC dimension of the mesial surface is being measured with a periodontal probe. The wall has only 2 mm of OC dimension [15].*

With the above explanation, 3 mm is recommended minimal OC dimension for premolars and anterior teeth. Because molars are larger than premolars and anterior teeth, prepared with greater convergence and are subjected to greater occlusal forces, 4 mm is recommended as the minimal OC dimension for prepared molars. If these minimal dimensions are lacking in preparation, it should be modified to increase the resistance form by proximal grooves/boxes. The ratio of 0.4 (OC dimension to the faciolingual (FL) dimension) is ideal for all teeth [14,15].

Circumferential form of the prepared tooth

The preparation of teeth should be in a way that they possess circumferential irregularity. During teeth preparation, teeth are anatomically reduced and show characteristic geometric forms such as when viewed occlusally, prepared maxillary molars to have a rhomboidal form. Mandibular molars have a rectangular form, and premolars and anterior teeth have an oval form [13].

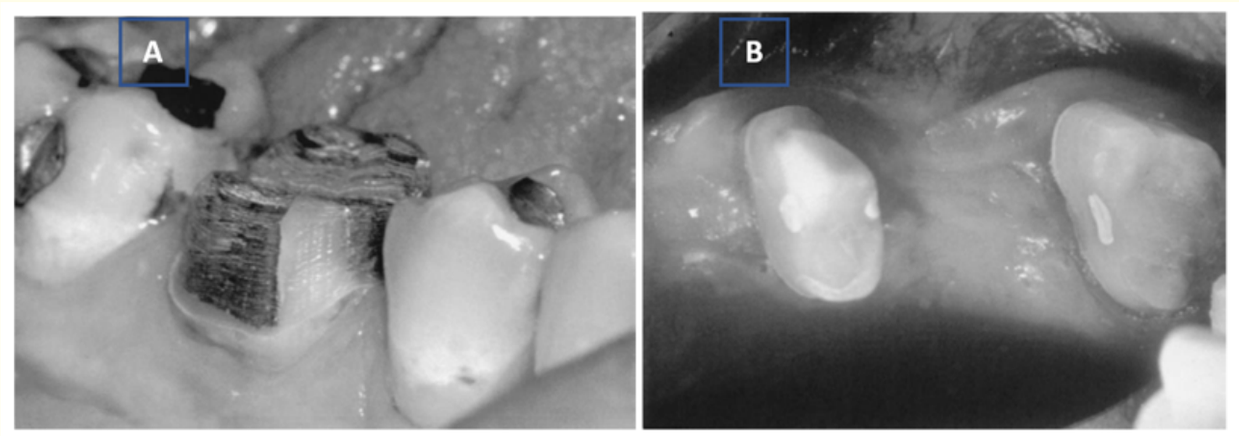

Figure 3: *Showing (A) Mandibular molars are prepared, have a rectangular form with rounded corners that enhance resistance form and (B) Prepared maxillary premolar has an oval crown form and the prepared molar resembles a rhomboid [13].*

The circumferential irregularity is produced by these shapes, and the value of which has been evaluated by comparing the resistance areas of conical and pyramidal tooth preparation. The pyramidal preparations are known to provide increased resistance. Hence, it is essential to preserve the corners of tooth preparation [13,16].

Finish line form

For different preparation, different finish lines are used for better retention and resistance of prostheses. For metal-ceramic crowns, chamfer, shoulder, or beveled finish lines are recommended. For all-metal crowns, those chamfer finish lines are placed. When the crowns are to be bonded to the prepared tooth, a chamfer or shoulder finish lines are can be used [13].

Cementation

Luting cement plays an important role in the retention of restorations for all those cement which bond to tooth and restoration, but passive luting cement merely acts as filler for the gap present between crown and tooth and adheres with restoration mechanically. For luting well-fitting metal and metal-ceramic definitive restorations, zinc phosphate cement has been used successfully because of being inexpensive, rigid material and with very high early compressive strength, but the drawback of cement is high acidic nature and solubility makes it no longer in use. Another pulp-friendly cement, such as polycarboxylate cement, has lower compressive strength but high tensile strength. Zinc oxide eugenol and zinc oxide non-eugenol cement present with good sealing abilities, but mechanical properties are inferior in comparison to other cement; its inherent brittleness and high solubility make it useful for provisional restorations or implant-supported crown [17,18].

Resin cement is typically indicated for metal-free restorations since they offer good strength, aesthetics, flexible working times, and very low solubility, but their drawback being technique sensitive, expensive, and hard to clean. Glass ionomer cement has fluoride release/recharge, good strength, optical properties, but with the drawback of short working times, and are sensitive to moisture (saliva) or dehydration [17,18].

Steps in tooth preparation

All the stage of tooth preparation has its own particular considerations, and the logical sequence helps in simplifying the procedure to a routine. The preparation sequence is as follow:

1. Buccal preparation: The desired margin preparation is 1 to 1.2 mm and axial surface preparation is 1.2 to 1.5 mm. The placement of depth orientation grooves (also called depth cuts) is the first step in buccal preparation Grooves placed removed larger areas of tooth reduction help ensure easy and controlled removal of tooth structure. A rotary instrument used for this is known. The depth of reduction can be measured against the unprepared tooth structure [19].

2. The interproximal preparation: A margin of 1 - 1.2 mm and axial surface of 1.2 - 1.5 mm is prepared. The proximal contacts are to be opened in this step. The aim of this step is only to open the interproximal contact without causing any iatrogenic damage to the adjacent tooth [19].

3. Lingual preparation: Desired margin of 0.5 mm and the axial surface of 1.2 - 1.5 mm is made. Just one depth groove is made, only half the bur width is sunken inside so as to avoid the formation of a lip of unsupported enamel. This margin is kept supra-gingival in an attempt to conserve tooth structure [19].

4. Occlusal preparation: A functional cusp of about 2mm and the nonfunctional cusp of about 1.5 mm is reduced. While reducing the occlusal aspect, it is essential to follow the pre-existing cuspal contours and inclination. On the buccal aspect, two dots are

marked, which represent the future cusp tips, which then are extended towards the proximal surface to develop a two mountain pattern that roughly represents the architecture of the final occlusal reduction needed. [19]

5. Functional cusp bevel preparation: The bulk of occlusal forces are withstood by functional cusps, which is achieved by providing a bevel on the functional cusp at 45° angle and is approximately 1.5 mm wide. This step avoids the creation of occlusal interference [19].

6. Finishing of the preparation: The final step of tooth preparation is finishing; no sharp line or point angles remain in the final preparation as these will cause stress concentration and ultimately failure of the restoration. The final preparation should be smooth and free of undercuts. The 360° margin of preparation should be continuous and visible when seen occlusally. This is assessed with one eye closed because an undercut is usually perceived as a near parallel surface when seen with both eyes open [19].

Figure 4: *Showing buccal preparation by placing buccal orientation grooves [19].*

Figure 4: *Showing buccal preparation by placing buccal orientation grooves [19].*

Figure 6: *Showing single depth orientation groove at lingual aspect and complete lingual preparation [19].*

Figure 7: *Showing occlusal preparation and correct angulation of diamond.*

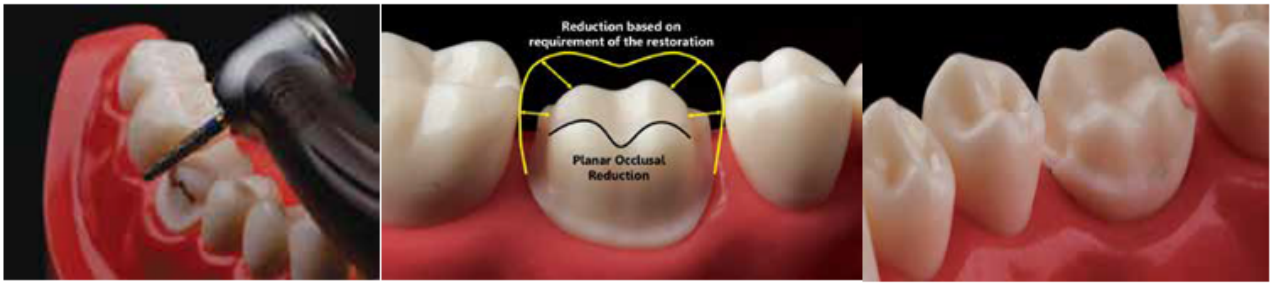

Figure 8: *Showing the placement of functional cusp bevel and final preparation ready to receive the crown [19].*

Conclusion

Tooth preparation is based on fundamental principles essential for the success of prostheses. Thorough knowledge and understanding of different criteria and pre-requisite in preparation is required for a better outcome. It is mandatory to reduce any iatrogenic damage to the pulp and adjacent tooth, use of copious irrigation, consideration of total occlusal convergence, occlusal dimension, placement of finish line, feather touch while preparation to have a smooth uniform margin to be placed subgingivally in aesthetic zone and lastly the use of appropriate luting agent in cementation of the prosthesis.

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