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### CONFRONTING TOOTH PREPARATION ERRORS- A REVIEW

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#### **ABSTRACT**

Full-crown restoration is a common achievement in restorative dentistry, and some dentists feel that instead of more conservative restorations there are too many crowns placed. The reasons behind the common use of full crowns are evident. Third-party payment companies typically pay for complete crowns on a regular basis, but often deny payment for more restrictive restorations such as inlays and onlays, or pay the fee amount for amalgam restorations. Regardless of the reasons, full-crown restoration is the cornerstone of teeth-restorative dentists who are largely carious or otherwise broken down. In any discussion with

dental laboratory owners and practicing laboratory technicians about the adequacy of tooth preparations numerous challenges arise immediately in tooth preparations for full crowns. As observed in dental laboratories, tooth preparations for crowns often have numerous deficiencies which limit laboratory technicians' ability to provide optimum service to their dental clients. Several aspects of full-crown tooth preparations have been discussed so that it could be used to improve and motivate readers to evaluate the characteristics of their own tooth preparations to see if changes are in order.

## INTRODUCTION

A fixed partial denture is a restoration that is luted or otherwise securely retained to the natural teeth, tooth roots and/or dental implant abutments that furnish the primary support for the prosthesis(1). The combined angle made by opposing axial(2) walls is called the convergence angle and it is measured against the vertical long axis of the tooth. The recommendation convergence angle is approximately  $5^\circ$  as the ideal, whereas a range of  $4$  to  $14^\circ$  is acceptable(3).

The shape of the prepared teeth and the amount of tooth structure removed are significant contributors to the overlying crown or fixed partial dentures mechanical, biological and aesthetic performance. Hence, the development of clinical guidelines that can be used to improve performance in fixed prosthodontics is important. Errors in following these instructions will affect the reliability and placement of these prosthesis(4).

Occlusal reductions, axial reduction, taper, finish line and undercuts in axial walls affect the consistency of preparation for extra coronal restorations(5). Goodacre et al received scientific preparation guidelines and proposed nine scientific principles to guide the preparation(6). It has been proposed that 3mm for incisors and premolars and 4mm for molars is the minimum occluso cervical scale. Of all metals, 1mm and 2mm respectively, of metal ceramic and all semi translucent ceramic systems, the axial and occlusal reductions are 0.5mm and 1mm deep(7,8). Despite the strict guidelines set for the preparation of teeth, laboratory technicians still face challenges in this regard. Errors in tooth preparation was identified as a second laboratory challenge immediately after impression was inadequate(9). The persistence of the problems of tooth preparation over a long period(10). It may be that these skills are difficult to learn, or there is a lack of credit hours in teaching this subject, or there may be no clear contact between the dentist and the technician in the laboratory. The problem has been the area of focus for several investigations which evaluated tooth preparation to see how much it is far from the ideal(11).

The study targeted preparation done by dental students(12–15), teaching staff(16), general practitioners(17), residents(18) and prosthodontics(19) and different results have been reported. Most previous studies focused on one aspect, ie- taper, and a few studies incorporated other aspects of tooth preparation, in addition to taper(20). Most of these were carried out in Europe, North America and Asia.

The popularity and potential of this topic comes from the wider use of fixed partial dentures(21). It provides good aesthetics, preserves arch form and is responsible for good function(22–24). However, there are certain challenges which might be faced. These include the need for improvement in the preparations carried out by all groups(25). There is quite a wide possibility of errors in visual estimation. There is also a considerable lack of advanced technology.

The vitality of the research lies in the fact that fixed partial dentures have a disadvantage of incorrect tooth preparation which may result in the crown falling off. The idea is that to identify the errors at the earliest, to nib them off and perhaps even try to fix it.

This research fulfils the deficiencies such as it compares previous literature and compares it with recommended values, finds the deviation pattern and suggests how to overcome it and state its effects.

The aim of this study is to confront tooth preparation errors so as to make the practitioners aware about the problems caused by the defective tooth preparations have been long noted. The purpose here, however is to motivate readers to evaluate the characteristics of their own tooth preparations to see if changes are in order – thus it provides easy understanding of the previous data and is easily comprehensible to all.

## **MATERIALS AND METHODS**

The study setting of this research is a scoping review(26). The approval from the research committee was not required since it is a review. The minimum number of articles is 20. In our research we have used 57 articles. The sampling and data collection was done by search engines like pubmed, google scholar, and from various other journals of prosthodontics. The articles were collected from 2000- 2020 (till date) although a few cross references date back to earlier dates even (Table 1).

After collection of all the articles, more specific articles were collected by using keywords such as tooth preparation, errors, fixed partial angle, occlusal reduction, bevelling.

There was a clear five step process in selection of these articles. Identification of clear objectives, identification of relevant articles, selection, data extraction and charting, analysis end report.

The inclusion criteria for the study was fixed partial denture crowns. The exclusion criteria was multiple missing or single unit crowns. The study was divided under various chapters, such as inadequate tooth reduction, finish lines and bevels, taper, undercuts and miscellaneous.

**Table 1: Article quality analysis (27)**

SL. NO	AUTHOR	YEAR	LEVEL	SOURCE	QUALITY OF RESEARCH
1	Ozdemir et al	2007	1	Scopus	Strong
2	Jain et al	2016	3	NCBI	Weak
3	Ayad et al	2005	2	Google scholar	Strong
4	Goodacre et al	2004	2	Pubmed	Moderate
5	Bokadia et al	2018	1	Pubmed	Moderate
6	Goodacre et al	2001	2	Google scholar	Moderate
7	Tjanet al	1980	3	Pubmed	Weak
8	Kharat et al	2015	2	Scopus	Moderate
9	Christensen et al	2007	1	NCBI	Moderate

10.	Christensen et al	2007	3	NCBI	Strong
11.	Buchanan et al	2000	2	NCBI	Weak
12.	Dorriz et al	2008	3	Pubmed	Weak
13.	Noonan et al	1991	2	Scopus	Weak
14.	Mack et al	1980	2	Google scholar	Strong
15.	Selvanet al	2016	3	NCBI	Strong
16.	Patel et al	2005	3	Scopus	Weak
17.	Enechiet al	2004	2	Scopus	Moderate
18.	Norlander et al	1988	1	Pubmed	Strong
19.	Arnetzlet al	2004	1	Pubmed	Weak
20.	Sato et al	1998	1	NCBI	Moderate
21.	Vinnakotaet al	2015	2	Scopus	Moderate
22.	Beueret al	2008	3	Scopus	Strong
23.	Cameron et al	2006	2	Pubmed	Strong
24.	Vijayalakshmiet al	2016	2	NCBI	Weak
25.	Parker et al	1993	3	Pubmed	Moderate
26.	Arksey et al	2005	1	Pubmed	Strong
27.	Ajay et al	2017	2	Google scholar	Strong

28.	Chansoria et al	2018	2	Pubmed	Weak
29.	Smith et al	1999	1	Scopus	Weak
30.	Albashaireh et al	1999	2	Google scholar	Moderate
31.	Proussaefs et al	2004	3	Google scholar	Moderate
32.	Duraisamy et al	2019	2	Scopus	Weak
33.	Bowley et al	2007	2	Pubmed	Strong
34.	Ganapathy et al	2016	2	Pubmed	Moderate
35.	Shetty et al	2010	1	Scopus	Strong
36.	Comlekoglu et al	2009	3	Scopus	Weak
37.	Subasree et al	2016	1	Pubmed	Moderate
38.	Tjan et al	1980	1	Google scholar	Moderate
39.	Campbell et al	1988	2	Scopus	Strong
40.	Kissov et al	2001	3	Pubmed	Moderate
41.	Ranganathan et al	2017	3	NCBI	Weak
42.	Kilicarslan et al	2004	1	Pubmed	Strong
43.	Prakash et al	2019	3	Pubmed	Strong
44.	Leles et al	2001	1	Scopus	Moderate
45.	Leempoel et al	1987	1	Google scholar	Moderate

46.	Jain et al	2018	2	Scopus	Moderate
47.	Rafeek et al	2006	3	NCBI	Strong
48.	Okuyama et al	2005	3	Google scholar	Moderate
49.	Kaliban et al	2018	2	Pubmed	Weak
50.	Owen et al	1986	1	Scopus	Moderate
51.	Owen et al	1986	2	NCBI	Strong
52.	Marghalani et al	2016	3	Pubmed	Strong
53.	Geramipanah et al	2005	1	NCBI	Moderate
54.	Jain et al	2018	3	Google scholar	Strong
55.	Silva et al	2013	2	NCBI	Moderate
56.	Jyothi et al	2017	1	Scopus	Strong
57.	Basha et al	2018	3	Pubmed	Weak

## RESULTS AND DISCUSSION

Tooth preparation is one of the main factors that influences the longevity of the restoration. Even though the present study has a sampling of articles of only further review with a large number of articles can help us to get to a more accurate conclusion. It is easy to observe the deficiencies in tooth preparations for crowns by critiquing dies in dental laboratories(28). We have tried to identify and discuss the major challenges into preparation noted by laboratory technicians and confirmed by dentists. Some of these discuss the negative characteristics which severely compromise the retention, aesthetics, strength and service potential of subsequently placed crowns.

Previously our team had conducted numerous clinical trials (29,30) and in-vitro studies (31,32) over the past 5 years. Now we are focussing on reviews. The idea for this review stemmed from the growing popularity of fixed partial

dentures and the problems faced by clinicians in the success rate of such procedures.

### **Inadequate Reduction**

A lack of adequate reduction on the incisal or occlusal surface is one of the problems most frequently encountered with tooth preparations for crowns. Regardless of whether the crowns are metal, porcelain fused to metal (PFM) or all ceramic, for optimum tooth anatomy reproduction, 1.5 to 2mm is needed(33).

Frequently, technicians are required to fabricate crowns on tooth preparations with 1mm or less of incisal or occlusion reduction. The occlusal reduction for the restoration should have indentations where the original tooth anatomy had indentations(34).

Some dentists use small, rounded, tapered or flame shaped diamonds for reduction of the mesial, distal, lingual and even facial walls(35). The result is minimum reduction and feather edge margins. For adequate restoration anatomy, mesial and distal walls should be reduced by 0.75 to 1mm for both PFM and all ceramic crowns(36). Facial reduction should be 1 to 1.25mm. Lingual may be less than 1mm if the metal margin is anticipated. Whenever load is applied on the lingual direction, the little margin ceramic is placed under compression. This compressive strength can be resisted by adequate length of abutment(37). Hence we should not over shorten the crown. Over reduction makes laboratory work easier but, the damage caused to the pulp is unpardonable(38). The rule of thumb should be used to remove as much tooth structure as required. Under reduction will lead to the crown to fall off.

### **Finish Lines and Bevel**

Finish line should be well defined, that is; no sharp line or point angle should be present. Leaving behind sharp line angles and point angles in the preparation can result in major fit issues and time-consuming appointments at the cementation time. Sharp line angles from possible sites for all ceramic(39) restoration lead to fracture stimulation. The solution to this is to round off all the straight line and point angles at the time of preparation. Clinicians also appear to neglect the values of smooth interval line angles lying at the function of axial walls and margins(40–42). A sharp internal line angle can cause excessive stress, trigger fracture and cause fit problems(43).

The sharp angles are left on the preparation, these parts of the dies can easily be scraped off by the technician, which causes the crown to fit property(44). Sharp line angles may also provide potential fracture for all-ceramic crowns.

Beveling of margins or creating a feather edge margin is contra indicated for all-ceramic preparation. To fabricate and all-ceramic restoration over bevelled finish lines is nearly impossible(45). For pressable ceramics(46), shoulder is required for strength at the margins because marginal areas bear much more support of the crown in function. This is because the best adaptation of the crown is at the cervical aspect(47). For all ceramic sure, chamfer is preferred



as the metal used, that is alumina or zirconia are inherently strong and do not require bulk of material for strength as is true for conventional ceramics.

**Rough shoulder-** They contribute to unnecessary buildup of stress at the margins. A smooth shoulder ensures an excellent fit, minimum cement line and good aesthetics.

**J margin-** Overzealous preparation of chamfer margin may lead to J-margin with unsupported and enamel tip. This happens when the operator goes deeper than the width of the head of the diamond while creating a groove. It is difficult to scan on CAD CAM.

**Pseudo shoulder-** Operator loses orientation to the proper plane of reduction and angulates the head of the bur too deep into the margins. It diminishes strength and aesthetics.

### **Taper**

The degree of taper for tooth preparation has been a debatable subject for long. Prior to the advent of resin cements, the dentists had to largely depend on good retentive form to retain the crown in place(48). Today with resin cement, the scenario is different. Achieving a near parallel surface is not considered critical anymore, as the cements bond very well to the tooth surface(49).

Investigation of a dies has confirmed that getting theoretical values of convergence angle in practice is very difficult(50). Studies on taper achieved by students have found that mean taper range from  $11^{\circ}$  to  $27^{\circ}$ . The mean taper of clinical anteriors(51) was  $31.6^{\circ}$  buccolingually and  $16.8^{\circ}$  mesiodistally, and the clinical posteriors was  $16.8^{\circ}$  buccolingually and  $22.4^{\circ}$  mesiodistally(52).

The average height of the abutment varied from 4.8mm to 6.9mm and it showed a close relationship with the taper of the abutment. The average taper in the study was  $9.5^{\circ}$ (53). The average calculated taper by a noncontact 3D shape measuring system suggested the average calculator taper to be  $5.8^{\circ}$  in the distal region,  $21.7^{\circ}$  in the buccal region,  $14.9^{\circ}$  in the mesial region and  $12.5^{\circ}$  in the lingual region.

A clinically feasible convergence angle in full coverage crown preparation has always been a matter of interest for laboratory and clinical researches(54). It meets the requirement for proper retention and resistance forms. It is recorded that clinical experience may not necessarily lead to a decrease in convergence angle during preparation(55). Posterior teeth have been recorded to have more taper, especially the mandibular molars. The retention of the casts decreases with increase in taper, that is- it is inversely proportional to the taper or convergence angle(56)

When cements such as zinc phosphate are used, preparation should be more parallel. When the characteristics are not met, lengthening of the crown is suggested by placing parallel vertical grooves.

### **Undercuts**

The presence of undesirable undercuts, due to clinical complicating factors such as poor visibility and access, are frequently observed. It hinders the complete seating of the cast restoration, which might result in the requirement to recontour the prepared tooth and make a new impression.

When these undercuts are left unattended, laboratory technicians must block them out before making the restoration. They result in poor fit of the internal portion and potentially reduce restoration retention(57). Retentive grooves, undercuts, channels and retentive pins are used to augment the bond to dentin produced by bonding agents. Properly placed buildups provide extra retention for the crowns, and they should be placed when indicated. Small voids in the tooth preparation produced by removal of previously placed restorations should be filled with resin modified glass ionomer, bonded to compomer or resin bonded-based composite to allow impression material to release easily from the tooth preparation(58).

### **OTHER ASPECTS**

These include less impactful but equally important aspects such as iatrogenic damage and extensive gingival extension.

Iatrogenic damage to the adjacent tooth is an unprofessional drawback. If one is through with their practice, mistakes should be avoided. It could cause excess financial burden to the patient.

Extensive gingival extension is for esthetic accessibility and caries prevention(59). When the positioning is appropriate from an esthetic perspective, margins are better positioned slightly sublingually or often supragingival. If caries or previously placed restorations require too much subgingivally, the crown should be lengthened to be permitted to heal properly prior to the appointment before tooth preparation(60).

### **LIMITATIONS**

Fixed partial dentures have a disadvantage that if the tooth preparation is incorrect, the crown falls off. Thus there is a need for improvement in preparation(61). There is a possibility of visual estimation errors in the reviewed literature if manually calculated data. There is also a lack of advanced technology.

### **FUTURE SCOPE**

These documented errors in tooth preparation can be used to implement rigorous training to reduce them, which will yield higher quality work and practice.

### **CONCLUSION**

Estimating how much of the tooth structure can be removed during tooth preparation without damaging the tooth remains one of the toughest challenges

if not the main challenge. Considering that the restoration margin can affect the periodontal tissues, a supragingival margin position should be preferred whenever possible. No finish line configuration has yet proved to be superior in terms of the subsequent restorations marginal accuracy. Alternatively, good marginal detectability for the dental technician or intraoral scanning systems tends to be of utmost importance to achieve good fitting restoration(62). General dental practitioners achieved mean convergence angles close to those recommended in literature, but the average taper, however it was thought to be clinically acceptable as it is difficult to achieve the ideal taper intraorally without sufficient practice. In the present study, a considerable amount of errors in tooth preparation in all aspects was observed. Hence, more rigorous awareness and training programmes need to be initiated to address this.

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