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Preparation Design Selection For Porcelain Veneers Manufacturing: A Review.

Katerina Zlatanovska^{1*}, Ljuben Guguvcevski², Cena Dimova¹, and Ivona Kovacevska¹.

¹Faculty of Medical Sciences – Dental Medicine; University “Goce Delcev” Stip, R. Macedonia.

² Faculty of Dentistry; University “Ss. Cyril and Methodi”, Skopje, R. Macedonia.

ABSTRACT

Due to high aesthetic qualities, proven biocompatibility and prognosis for long term durability, porcelain veneers have become a routine restorative procedure for frontal teeth treatment. From a mechanical point of view, porcelain veneers are fragile and brittle before cementing. After fixation they gain the necessary pressure strength, and become more tensile and resistant to bending, which guarantees their clinical longevity. Besides the strength of the material, the mechanical resistance of the veneers will also depend on the preparation design, which altogether will withstand the occlusal and lateral forces during mastication. An important decision that has to be made before starting preparation is to choose one of the four types of preparations. The actuality of the issue and more frequent use of veneers in everyday clinical practice, require vindicating and clearly define the type of preparations that will give better performance on fixed-prosthetic works. Reviewing the literature, we recognize that there are many ambiguities and controversies about the preparation designs, especially for incisal overlap. All of the described types of preparations have their strengths and weaknesses, but the latest studies promote incisal overlap preparation as the best. Long-term clinical trials and in vitro tests are required in order to clarify the dilemma.

Keywords: Adhesion, Esthetic Restorations, Mechanical Resistance, Porcelain Veneers, Preparation Designs

**Corresponding author*

INTRODUCTION

The patients' desire for aesthetic correction of the front teeth is rapidly increasing. Until now, in order to satisfy these requirements, crowns were used as the most durable and the best solutions. This type of treatment is very invasive, though, with irreversible removal of large amounts of tooth substance and possible occurrence of negative effects on the pulp and periodontal tissues. The appearance of porcelain veneers is a modern aesthetic solution that meets the new demands for a beautiful and attractive smile. [1]

As with any other technique that is in the process of development, the use of porcelain veneers require long-term studies in order to confirm their usability and to allow them to continue to be used to reduce or expand their indications in the population. [2, 3] When bonded with proper adhesive technique and if optimal oral hygiene care is maintained, studies have shown that the long-term survival rate of porcelain veneers is very high. [4]

Indications and contraindications

These kind of restorations are ideal if we want to improve the smile aesthetically, to eliminate the aesthetic disadvantages such as discolored teeth, chipped, crooked, broken, misshapen teeth, diastema median, badly positioned teeth (but only some orthodontic anomalies), lingual inclination, fillings and old aesthetic prosthetic works that do not satisfy. [4, 5] With the development of veneers once limited field of indications is extended and patient is offered with new opportunities for restoration, thereby suppressing crowns as more invasive solution. [6]

On the other hand, when we talk about contraindications for making porcelain veneers we should consider that preparation of tooth surface, even minimally, is an irreversible process. In the cases where aesthetic correction may be performed by more biological means, porcelain veneers should not be used. In cases where possible, priority should be given to orthodontic treatment for correction of teeth position irregularity. As a "temporary" contraindication is using porcelain veneers before 16-18 years because of teeth germination and alveolar bone growth. [7] Bruxism is general contraindication. Basically, it is contraindicated also for treatment with implants and ceramic restorations. Structural defects like Amelogenesis imperfect and Dentinogenesis imperfect, which leave insufficient enamel and tooth structure for bonding, are a specific contraindication for veneers. [8] Some authors indicate harmful habits, like nibbling on fingernails and pencils as a contraindication for making porcelain veneers.

Another contraindication for porcelain veneers is bulimia and poor oral hygiene. At bulimia, as a result of frequent vomiting, the enamel of palatal surface on upper teeth erodes and that is why it is impossible to use porcelain veneers. Anyway, no matter the reason, eroded palatal enamel is a contraindication for making veneers. In those cases crowns are chosen for the restoration. [9]

Techniques and preparation designs

In order to satisfy the aesthetic requests, techniques for producing veneers and materials are constantly being improved. The techniques can generally be divided into direct and indirect techniques. At direct techniques we choose to use composites, while at indirect techniques there are plenty of materials that can be used, including:

- Conventional ceramics – feldspathic porcelain – layering of porcelain powder and liquid
- Press ceramics - these products are based on replacing the wax with ceramics at high temperatures
- CAD / CAM ceramics

Besides the strength of the material, the mechanical resistance of the veneers also depends on the preparation type, which altogether will withstand the occlusal and lateral forces during mastication.

An important decision that should be made before starting the preparation is whether the incisal edge will be reduced or not. Preparation designs contingent upon reducing of the incisal edge can be:

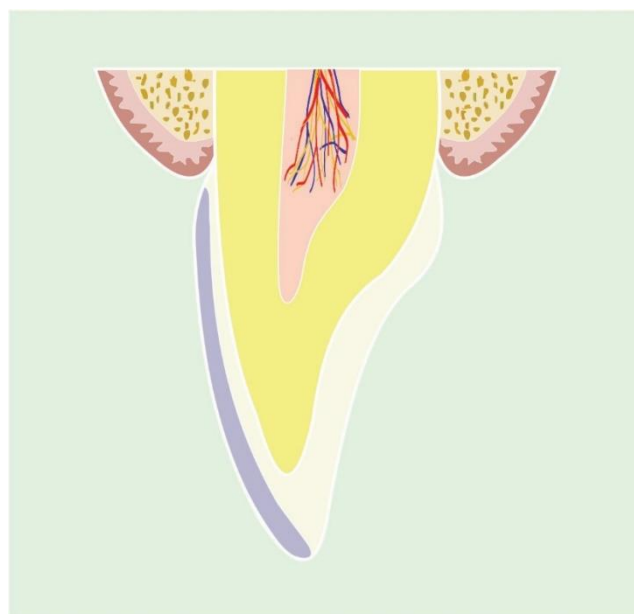
- Window preparation
- Feather preparation
- Bevel preparation
- Incisal overlap – palatal chamfer

Window preparation, described by Grabber, where the incisal edge is not reduced, veneer is bonded to the labial surface of the tooth and ends near incisal edge. The advantage of this preparation is that it leaves the incisal enamel intact, but it also weakens it. Also, the edges of the veneer become sensitive in situation of incisal abrasion. Sometimes they do not satisfy aesthetically because the composite resin can be seen. [Picture 1]



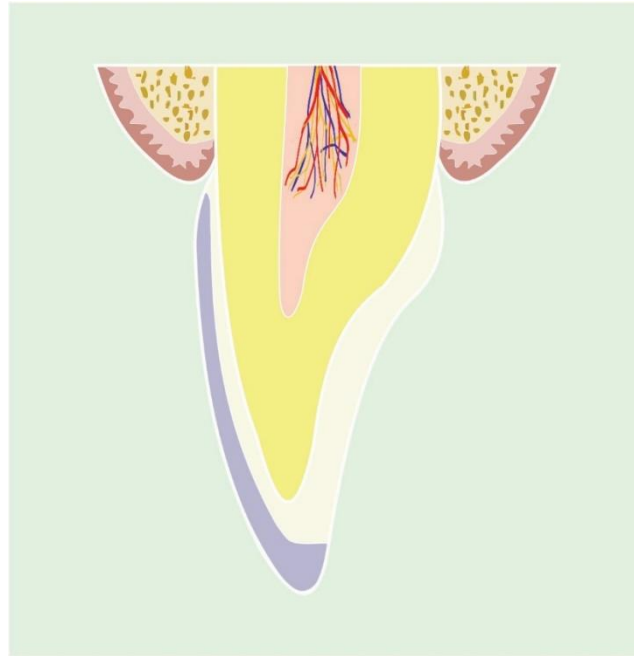
Picture 1 (window preparation)

Feather preparation, where the veneer covers the entire labial surface till the end of incisal edge, but the same is not reduced in length. The advantage of this preparation design is that patient's incisal guide is preserved. These veneers are prone to breaking and debonding especially during protrusion. [Picture 2]



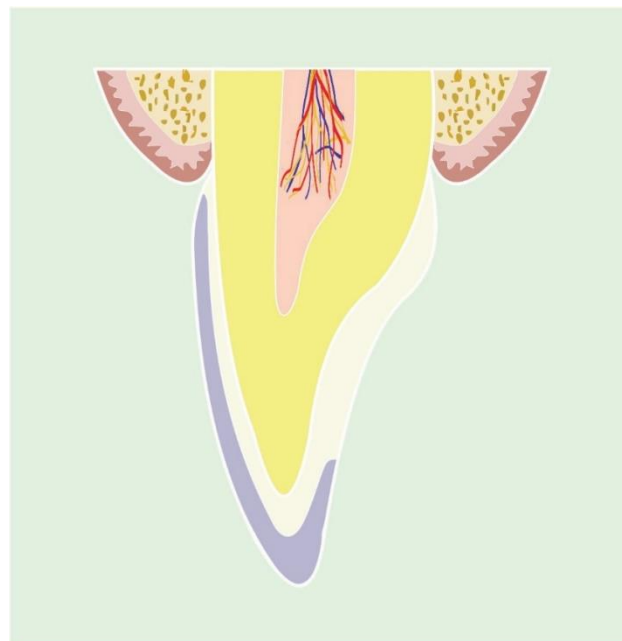
Picture 2 (feather preparation)

Bevel preparation, where we prepare bucco-palatal tilt over the entire tooth width and there is incisal tooth reduction. That enables better aesthetics, easier try in and bonding of the veneer. The placement of the finishing line is such that the veneer is not subjected to the action of shear forces, except propulsion. However, this preparation design includes greater reduction of the hard tooth substance, which is irreversible. [Picture 3]



Picture 3 (bevel preparation)

Incisal overlap (palatal chamfer), where the incisal edge is reduced and the preparation has palatal extension. Aesthetics is excellent and the clinical phases of try in and bonding of the veneer are much easier. This preparation design also changes the direction of entering of the veneer from pure bucco to bucco-incisal. [Picture 4]



Picture 4 (incisal overlap-palatal chamfer preparation)

Advantages and disadvantages

In order to distinguish the indications and contraindications for aesthetic restorations with porcelain veneers, it is necessary to consider their advantages and disadvantages. The best way to do it is through the prism of the three main characteristics for aesthetic restoration. A prosthetic therapy is considered to be good if biological, aesthetic and mechanical properties of the same are balanced.

Biological characteristics are presented through its impact on the pulp and periodontal tissue. In any other case, there is not so much saving of the tooth substance than with porcelain veneers. In most cases preparation depth is from 0.3 to 0.5 mm. There are also clinical situations that can be solved without preparation. Regarding the periodontal tissue, porcelain veneers are characterized by exceptional tolerance and we can expect no or minimal periodontal response. [10, 11] Important factors for maintaining optimal periodontal health are good oral hygiene and smooth and polished margins. [9, 12]

When analyzing the aesthetic features, we should note that porcelain veneers possess all the necessary preconditions for a highly aesthetic restoration. By using porcelain veneers we can correct not only the color of the teeth, but also their shape and position of one or a group of teeth.

From a mechanical perspective, before cementing porcelain veneers are gentle and fragile. After fixation with composite cement they gain the necessary pressure strength, and become more tensile and resistant to bending, which guarantees their clinical longevity. Many authors have examined the mechanical resistance of veneers, longevity and ability to resist the occlusal and lateral forces of chewing pressure during mastication. Considering that they are in correlation with hardness of the material they are made of and also the preparation design, the current in vitro and clinical studies show very contradictory results.

Some authors suggest that the most conservative type of veneer, i.e. window preparation, is the best choice when the strength plays an important role in choosing the type of preparation design. They found that in incisal overlap preparation design the stress concentration will be maximally transferred to the veneer which increases the risk of fracture or veneer debonding. [12, 13]

Other authors came out with different results in their in vitro studies. They believe that if the finish line is closer to palatal concavity there is greater possibility of veneer fracture. This was confirmed by Deisi Carneiro da Costa et al. in their research where during a period of 6 months they electronically searched the PubMed, Web of Science and Cochrane and encompassed 2347 studies. They concluded that the most resistant to fracture are veneers with bevel preparation design, while fracture frequency was greatest in incisal overlap-palatal chamfer preparation type. [14]

Abd-El Ghani Mirra and Salem El-Mahalawy obtained similar results in their in vitro study Fracture Strength and Microleakage of Laminate Veneers. They comprised 30 maxillary central incisors, divided into three groups as feather, bevel and incisal overlap-palatal chamfer preparation design. Porcelain veneers made of InCeram were tested on L Loyed-universal testing machine. The greatest value for fracture resistance was registered in veneers with bevel preparation (524.56 ± 63.07 N), then feather preparation with 460.93 ± 58.56 N, and the lowest fracture strength in veneers with incisal overlap-palatal chamfer of 440.56 ± 46.21 N. These differences in values between different types of preparation were statistically significant. [15]

Contrary to the abovementioned, in vitro study conducted by Schimdt et al. at the University of Washington, examined the strength of fracture resistance among four types of preparations, bevel preparation in healthy and damaged teeth and incisal overlap – palatal chamfer preparation design in healthy and damaged teeth. Porcelain veneers were made with press technique and later placed in universal testing machine (Instron, model 5585H). The pressure was applied 1mm from incisal edge with angle of 90° to the palatal surface of the tooth, until total damage of the experimental sample appeared. That power was defined as a fracture strength of the veneer. In addition, the highest value was observed in healthy teeth with incisal overlap-palatal chamfer (166.67 ± 28.89 N), lower value in healthy teeth with bevel preparation (131.84 ± 18.88 N), then damaged teeth with incisal overlap-palatal chamfer (119.56 ± 23.88 N) and the lowest in damaged teeth with bevel preparation (90.56 ± 9.32 N). [16]

Besides the laboratory examinations, like any technique that is under development, the use of porcelain veneers needs long-term clinical studies that would confirm their usability and show how they react when they are in function. However, there are contradictory opinions when it comes to incisal edge reducing.

In a clinical study by R.Smales and S.Etermadi from 2004 they followed the long-term survival of porcelain veneers for a period of seven years, depending on the type of preparation. They concluded that although it is believed that veneers with reduced incisal edge have better endurance and survival rate of veneers, the same is not statistically significant. They made 110 porcelain veneers on 50 patients, 46 of whom with incisal overlap and 64 with window preparation design. The results after 7 years were survival rate of 95.8% when incisal edge is reduced and 85.5% when it is not. With their study they confirmed that although the difference is not statistically significant, veneers with incisal overlap tend to have better survival rate. [17] In another clinical study where Granell-Ruiz studied 323 veneers of front teeth in a period of 3 to 11 years they registered fractures in 4% of veneers, which was slightly higher than the other investigations. However, in this case most of the patients had a history of bruxism. At the same time the veneers in these patients were made of feldspathic porcelain that has lower mechanical properties. Yet, they noted that the incidence of fractures is greater when incisal edge is reduced, compared to window preparation, where incisal edge is preserved. [3] According to some other clinical trials, authors preferred other types of preparation over the incisal overlap, especially in vital teeth. In a retrograde study that examined 292 teeth restored with porcelain veneers, two types of preparation were compared where 245 were with incisal overlap and 47 with feather preparation. After two years monitoring, the authors recommended not to reduce the incisal edge when preparing for veneers. [18]

Several authors suggest the incisal overlap - palatal chamfer as the best preparation design. [19, 20] This type of preparation design allows the dental technician to have more control over the incisal aesthetic features of the porcelain veneers. In addition, this preparation makes the restoration more resistant to incisal fractures.

So far, the specific characteristics of porcelain veneers were described, which can be defined as their advantages. Some of them can also be evaluated as disadvantages. Porcelain veneers are defined as technologically sensitive - the final result depends on the precise fulfillment of every clinical and laboratory stage. The unique qualities of porcelain veneers are gained as a result of the time spent for both clinical and laboratory phases. Although we have minimal preparation, we spend more time because the clinical phase – preparation should be carried out with better care and precision. The higher cost of a porcelain veneer compared to metal ceramic crowns is pointed also as a disadvantage.

The significance of the issue, the more frequent use of veneers in everyday clinical practice, seek clarification and a clear definition of the type of preparation which will give better performance of fixed-prosthetic works. Reviewing the literature we must admit that there are many uncertainties and controversies about the kinds of preparation, especially for incisal overlap design. All of the four types of preparation, described so far, have their advantages and disadvantages, but recent studies promote incisal overlap-palatal chamfer preparation as the best. Long-term clinical trials and in vitro tests are required in order to clarify the dilemma.

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