Margin designs for esthetic restoration: An overview

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Abstract:
Variations in margin designs for metal ceramic restorations have been used to fulfil the many requirements for such restorations. The use of a collarless metal ceramic fixed partial denture is a viable approach for restoring dentition where the aesthetic quality is the primary concern. The absence of the metal collar in the buccal portion of the abutments provides an excellent aesthetic appearance. However, success of such type of restorations requires proper tooth preparation, which includes proper selection and preparation of the cervical margin design.

Key words: Cervical margin, collarless porcelain, metal ceramic.

Introduction:
Metal ceramic and all-ceramic crowns are used frequently to restore esthetics and function. A porcelain-fused-to-metal (PFM) crown restoration is considered successful only when biological, mechanical, and esthetical concerns are satisfied.\(^1,2\) Restorations with poor marginal integrity may contribute to the cause of severe caries and periodontal defects.\(^3\) The most important factor in achieving successful marginal integrity is preparation design. Inadequate tooth preparation can also lead to esthetic failures. Thus, inadequate quality of tooth preparation seems to be a common thread contributing to metal ceramic crown failure.\(^2,3\)

In many patients, margins must be placed in an intra-crevicular position to provide an acceptable esthetic result. Such patients may have thin, friable gingival tissues, and a metal collar beneath the gingiva gives a blue-gray, cyanotic appearance to the tissue. Alternately, porcelain fused to metal (PFM) crowns may sometimes be associated with grayish discoloration at the cervical third of the restoration due to thinness of porcelain in this area and in the adjacent tissues due to reflection of light meeting the opaque substrate of PFM restoration and thin gingival tissues. This is an optical effect that is more noticeable when the upper lip is not retracted and has also been described in the literature as umbrella effect.\(^4\) Therefore in order to improve aesthetics with metal ceramic restorations proper selection and placement of the cervical finish line without encroaching on the biologic width and an extended porcelain labial margin is essential.\(^4,7\)

Criteria for margin selection:
While adequate tooth reduction is necessary to provide sufficient space for the metal and ceramic to satisfy both aesthetic and mechanical requirements, such a reduction should be accomplished without endangering the pulp or supporting periodontal structures. Therefore, ideal finish line should allow for optimum thickness of both metal and porcelain to satisfy the mechanical and aesthetic requirements.

1. The selected margin must provide a predictable level of marginal integrity.
2. To minimize plaque accumulation, the selected margin must present smooth materials to the gingival sulcus.
3. The margin also must provide acceptable esthetics.\(^6,9\)

Margin designs:
Few studies relevant to margins design with esthetic and biological acceptability are described in table 1.

There seems to be a general consensus regarding the principles and characteristics of the tooth preparation required for a metal ceramic crown, except with the configuration of the labial finish line. With metal-ceramic crowns, there are five potential cervical margins to consider. With metal-ceramic crowns the potential cervical margins to considered are- Knife-edge, flat shoulder (butt-joint), 135° shoulder (long bevel, sloped shoulder), flat shoulder with 45° bevel
Marginal integrity:

There are three cervical margin designs that seem to meet the criterion related to acceptable marginal integrity. These include the shoulder, the shoulder-bevel and the sloped/slant shoulder. A 90 degree shoulder is probably the most commonly used margin designs for porcelain fused to metal (PFM) restorations. The shoulder and shoulder-bevel margin seem to resist distortion due to the inherent bulk of metal at the margin. The shoulder and shoulder bevel also meet the criterion related to the use of smooth materials in the gingival crevice. The shoulder can be used with a metal margin, which can be highly polished, or with a porcelain margin, which results in glazed porcelain in the sulcus. These designs require the removal of a significant amount of tooth tissue to provide a predictable restoration. This increases the risk of irreversible damage to the pulp, particularly if little tooth tissue is present, for example on exposed roots. In these situations more conservative designs, such as the 135 degree shoulder (Slant Shoulder) or deep chamfer, should be considered.

Esthetic considerations:

From esthetic view point shoulder with bevel is accompanied by inherent display of metal because it has a polished metal collar of 1 mm or more. Porcelain covering is impossible with shoulder with bevel margins. If the metal is thinned significantly, the margin will distort when the porcelain is fired, which negates the advantage of improved fit. Porcelain covering the bevel may shrink to the region of greatest bulk resulting in porous and unaesthetic appearances. Hence, shoulder-bevel margin should be used only in situations where esthetics is not important.

Therefore, in situations where esthetics is important, the clinician has three options. The first is to use an all-ceramic crown. Although there has been lot of advances in improving the longevity of all ceramic crowns, still metal-ceramic crowns have shown predictable long term service and are still considered the restoration of choice.

Two alternatives to improve esthetics with metal-ceramic restorations while maintaining the marginal integrity are- the porcelain labial margin (shoulder) and slant shoulder with disappearing margin. There is inherent roughness of the disappearing margin due to the presence of three different materials i.e oxidized metal, opaque porcelain and body porcelain at the terminus of the margin. Thus, all-porcelain labial margin metal ceramic restoration has proven to be a viable alternative to the conventional metal ceramic restoration in aesthetically demanding restorative situations.

Porcelain labial margin:

The margin of choice in esthetic situations when using metal-ceramic crowns is a shoulder design with a porcelain labial margin. This design allows for an adequate thickness of ceramic material at the margin so that a predictable esthetic result is assured, provides excellent strength, and places glazed porcelain in the gingival sulcus. A rounded internal angle should be prepared to end at approximately 90° to the external angle of the labial or buccal surface. A slight slant of no more than 5° is acceptable. The margin should be as smooth as possible, and, to provide optimum esthetics and strength, should be between 1.2 and 1.5 mm in depth. This design provides adequate bulk for esthetics and strength and places the cervical margin in compression during function. It also permits the restoration to be glazed without rounding of the terminal ceramic margin.

Several techniques have been described for fabricating porcelain margins, and all seem to provide acceptable results if the margin has been prepared properly and the technician pays meticulous attention to detail.

Laboratory techniques to fabricate porcelain labial margins:

Laboratory techniques have been classified as platinum foil, refractory die, direct lift and porcelain wax technique. Platinum foil technique:

This technique has been used for many years with excellent results and is considered the standard to which other methods are compared. The platinum foil is secured to the metal coping with wax, by spot welding, or with a metal-ceramic coating agent. The use of platinum foil facilitates the removal of the porcelain from the margin. To ensure that the coping is correctly oriented and completely seated on the die, internal relief of the casting or die must be provided to accommodate the platinum foil. The thickness of the most commonly used foil is 25 μm, thus automatically creating a marginal discrepancy of that magnitude plus whatever deficiency results due to porcelain shrinkage. Another consideration is the rolling effect of the edge of the all-porcelain margin during the glazing cycle due to the thermoplastic nature of dental porcelain. Variation of the platinum foil method forms a margin.
without providing relief, thus raising the coping above the die by the thickness of the foil.

Table 1: Studies describing margins design with esthetics and biological acceptability

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Study Description</th>
<th>Methodology</th>
<th>Conclusion</th>
</tr>
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<tbody>
<tr>
<td>Jalalian E et al. [1], 2008</td>
<td>Evaluating the effect of a sloping shoulder and a shoulder bevel on the marginal integrity of porcelain-fused-to-metal (PFM) veneer crowns.</td>
<td>An in vitro experimental analysis</td>
<td>Marginal integrity of both preparation designs was found to be similar. Since the sloping shoulder design offers biological and esthetical advantages over the shoulder bevel, its use is indicated for anterior restorations.</td>
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<tr>
<td>Gardner et al. [18], 1997</td>
<td>This in vitro study compared the load necessary to cause porcelain failure on traditionally fabricated metal–ceramic crowns cemented to metal tooth analogs with two different types of margins.</td>
<td>In vitro experimental study</td>
<td>The load required to cause porcelain fracture in the crowns with porcelain facial margins was statistically significantly greater than the load required to cause porcelain fracture for crowns with metal collars.</td>
</tr>
<tr>
<td>Bishop K et al. [7], 1996</td>
<td>Margin design for porcelain fused to metal restorations which extend onto the root.</td>
<td>Literature review</td>
<td>A 90 degree shoulder is probably the most commonly used margin design. This increases the risk of irreversible damage to the pulp, particularly on exposed roots. More conservative designs, such as the 135 degree shoulder or deep chamfer, should be considered.</td>
</tr>
<tr>
<td>Boyle J. [19], 1993</td>
<td>This study compared porcelain facial margins made with the direct-lift technique using high-fusing shoulder porcelains and the platinum foil technique with conventional body porcelain.</td>
<td>An in vitro experimental analysis</td>
<td>Porcelain marginal roundings can be manifested as either negative roundings or underextensions and positive roundings or overextensions. The lack of marginal sharpness of porcelain facial margins may be influenced more by the die material rather than by the marginal porcelain or the technique.</td>
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<td>Belles et al. [3], 1991</td>
<td>This investigation examined the marginal characteristics of the collarless metal ceramic restoration made with two commonly used direct-lift techniques: (1) a porcelain/wax paste (2) a porcelain/liquid slurry.</td>
<td>In vitro experimental analysis</td>
<td>The group made with the porcelain/liquid technique with the metal on the die shoulder produced the most consistent overall results.</td>
</tr>
<tr>
<td>A J Hunter, A R Hunter [8], 1990</td>
<td>Review and discussion of the gingival crown margins configurations</td>
<td>Literature review</td>
<td>Horizontal margins can be made accurately and, when combined with procedures to maximize crown seating, may provide the best method of minimizing seating discrepancies and maximizing gingival health.</td>
</tr>
<tr>
<td>Omar et al. [24], 1987</td>
<td>Scanning electron microscopy of the marginal fit of ceramometal restorations with facially butted porcelain margins</td>
<td>In vitro experimental analysis</td>
<td>The marginal openings for facially butted metal ceramic crowns were greater than the bevelled shoulder marginal design but less than the porcelain jacket crown. Aesthetics and the favourable contour of the facially butted porcelain are distinct advantages but are accompanied by increased laboratory time.</td>
</tr>
<tr>
<td>Donovan et al. [9], 1985</td>
<td>Major types of margin configurations for ceramometal crowns are reviewed.</td>
<td>Literature review</td>
<td>Underprepared teeth produce discolored gingiva and chalky crowns.</td>
</tr>
</tbody>
</table>
This compensates for the thickness of the foil and porcelain shrinkage. Use of the platinum foil technique requires an exceptionally critical tooth preparation. A smooth labial shoulder must be prepared to facilitate adaptation of the foil. Another significant disadvantage of the foil technique is lack of direct visualization of the margin during contouring.

Refractory die techniques:

The principle of refractory die technique involves avoiding intermediary materials and baking the margin directly on a refractory die, improved marginal integrity will result. An alternative technique using a metal-ceramic coating agent on the shoulder causes the porcelain to shrink toward the margin, which may improve the fit even more. Satisfactory results can be achieved; however, both techniques can be exceedingly demanding. The relative lack of color differentiation between the refractory die material and the body porcelain can be a difficulty when shaping the margin. The additional step of die duplication, coupled with the friability of refractory materials, has made these techniques less attractive. Newer refractory materials that are less friable may facilitate the technique.

Direct lift technique:

The direct lift concept involves adapting the porcelain directly to the die and lifting it off intact with the aid of a separating medium. A hardened die, either electroplated or of improved stone with a cyanoacrylate coating, is essential. There are a number of variations of the direct lift technique, the differences relating to porcelain materials used and the sequence of steps taken to achieve marginal closure. The main advantage of direct lift technique is relative simplicity. There is no need to meticulously adapt platinum foil or to make a refractory die, which may be fragile. However, the technique is many times more demanding than would appear at first glance. The first problem is lifting the green porcelain from the die. Secondly due to porcelain powder water discrepancies, porcelain will not flow into small gaps without disturbing the film of the separating media.

Direct lift (cyanoacrylate) technique:

The substructure is fabricated in the same manner, but the die is coated with a layer of cyanoacrylate resin, and the porcelain is condensed directly onto it (because the die no longer absorbs moisture from the wet ceramic buildup). Separation is achieved with a porcelain release agent. As with most techniques, a second bake is usually necessary for satisfactory marginal adaptation. The principal difficulty associated with the cyanoacrylate technique occurs during the staining and glazing. Because the porcelain is not supported as in the platinum foil technique, the margin tends to round off slightly; therefore, special shoulder powders are needed.

Porcelain wax Technique:

A mixture of body porcelain and wax (6:1 by weight) is applied to the shoulder. Significant advantages are apparent with this system. The problem of lifting the porcelain off the die is eliminated. The porcelain-wax suspension seems to flow readily into minute marginal gaps, eliminating the problems resulting from adding porcelain to the margin after removal from the die and then attempting to reseat the crown. Margins of multiple splinted crowns may be done simultaneously due to the ease of porcelain shaping, lift-off, and the rigidity of the formed porcelain-wax margins. The porcelain-wax system may be used with any of the previously discussed direct lift techniques. An advantage of this method is that one shade of porcelain-wax will suffice for most restorations since such a small amount forms the gingival margin.

Conclusion:

Shoulder margins with a labial or buccal porcelain margin are indicated in situations where esthetics is paramount. Previous comparison studies have shown that the marginal adaptation of the all-porcelain labial margin metal ceramic restoration is very technique sensitive. However, they still remain as a viable alternative in improving the esthetics in metal ceramic restorations.

References:

3. Bell AM, Kurzaja R, Gamberg MG: Ceramicmetal crowns and bridges. Focus on...