

REVIEW ARTICLE

A Systematic Literature Review on Marginal fit of Metal Copings of Different Porcelain Fused to Metal Alloys

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ABSTRACT

Precise marginal fit is an essential and critical factor for a successful dental cast restoration as intraoral degradation of cement can result in loss of marginal seal and promote retention of plaque. Marginal fit of the casting is one factor that can lead directly or indirectly to development of secondary dental caries, adverse pulpal reaction, and periodontal disease. Marginal seal essentially depends on the surface characteristics of the margins, adaptation of casting and the luting cement used. Inadequate fit of a coping due to poor marginal seal can lead to a thin line of the cementing medium exposed to the action of saliva, foreign bodies and oral fluids, encouraging problems under the restoration and finally tooth loss. The presented literature review is an endeavor to emphasize the chronological approaches, different pioneer researches, different controversies, problems and modern drifts for casting of metal employing various techniques. A detailed literature exploration was conducted using MEDLINE/PubMed databases and other scholarly research bibliographic databases. Studies describing research studies and in-vitro studies were retrieved and evaluated from 1948 to 2018.

Key words: Porcelain, Ceramic, Marginal fit.

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INTRODUCTION

Today, numerous low gold and base metal alloy systems are being developed and marketed for dental applications. These alloy systems are now used extensively to make cast restorations, particularly for metal substructures of ceramometal crowns. The increased popularity of porcelain fused to metal restorations is due to ever increasing esthetic demands, improvement in casting techniques and alloys along with wide application in all clinical situations including even complex restorative needs.^[1-2] Tooth preparation for fixed prosthesis should respect the biomechanical guidelines involving the biological, mechanical and esthetic factors for optimum success. In selecting an alternative alloy for a cast restoration, one of the several important factors to be considered is the dimensional accuracy of resultant casting. The casting must adapt precisely to the prepared tooth, with a good marginal fit.^[3-4] It is gratifying to elicit in non gold alloys that some desirable properties are better than those of gold alloys. Their increased hardness and strength are of great significance as they play an important role in conservation of tooth structure by requiring lesser amount of tooth reduction for restoration with these alloys. The need of a casting ring for phosphate bonded investment was not questioned till now as it was a standard and an established procedure. According to recent studies the high strength of these investment materials makes it possible to abandon the use of the casting rings. The ringless techniques are easier, less expensive, and give

clinically acceptable castings. The advantage of a ringless technique, is not the restriction of thermal expansion that is associated with the presence of the metal ring.^[5-10] In the literature there are very few studies to support the assumption that ringless casting technique can produce accurate castings for fixed partial dentures. Improper marginal seal can encourage plaque and bacterial deposition resulting in secondary caries and periodontal disturbances with concomitant deterioration of the restoration.

METHODS OF LITERATURE SEARCH

Biomedical literature was extensively explored over internet platform. It searched exactly into the existing pool of existing biomedical information database. Various internet based trendy search engines (Google, Google Scholar, Yahoo), scholarly search bibliographic databases (PubMed, PubMed Central, Medline Plus, Cochrane, Medknow, Ebsco, Science Direct, Hinari, WebMD, IndMed, Embase) and textbooks were searched until June 2018 using MeSH (Medical Subject Headings; PubMed) based keywords such as "Porcelain", "Ceramic", "Marginal fit", "Casting", "Metal Margin". We had made sure restrict the searches only to reviews, systematic researches, meta-analyses and clinical guides in various dental journals published over the last 70 years in English. A total of 107 articles were identified however after examining the titles and abstracts, this number was finally reduced to 42 articles.

SYSTEMATIC LITERATURE: DISCUSSION

Wright and associates^[11] conducted a study for the evaluation of three variables affecting the casting of base metal alloys namely the effect of venting, sprue width and thickness of investment covering the end of the pattern. In their study they used methyl methacrylate resin for the fabrication of casting patterns and regarded them better in strength, ease of manipulation and measurement and lack of distortion. They also found that All the vented samples with sprue widths of 2 mm or more were defect free, whereas the corresponding unvented samples had extensive voids and porosity not in all but one casting. **Duncan**^[12] studied the casting accuracy of nickel-chromium alloys for fixed prosthodontic work. He found out that on comparing with gold alloys, nickel-chromium alloys have a wide range of physical and mechanical properties like higher yield strengths and moduli of elasticity, greater percentage of elongation, which is an index used to predict burnishability. **Vermilyea and colleagues**^[13] investigated the casting accuracy of five base metal and three investment material (Ceramigold 2 and Hi-Temp and Neoloy Hi-Heat Crown and Bridge Investment). The result of this study showed that only 8% was adequate casting while 23% oversized 49% undersized. They found that there is effect of investment material on the casting accuracy because overall, the fit of the test castings was poor and individual alloy-investment interaction was significant. **Paulino and coworkers**^[14-15] compared the castability of pure titanium with Ni-Cr and Ni-Cr-Be alloys. The degree of marginal rounding was measured and margin length deficiencies (μm) were calculated. Sixty acrylic resin crown patterns with wax margins were prepared on a stainless steel crown die having a 30-degree beveled finish line. The degree of wax margin rounding was determined in the control group (group W, n=15). The remaining 45 crown patterns were divided into 3 groups (n=15) and cast in commercially pure titanium (Tritan, group Ti), Ni-Cr-Be alloy (Verabond; group VBI), and Ni-Cr alloy (Verabond II; group VBII). Margin configurations for both wax patterns and cast specimens were measured and recorded with the same method, using silicone impressions of the margins. **Felton and other**^[16-17] discussed the effect of air abrasives on marginal configurations of porcelain fused to metal alloys. Separate dies were milled to produce chamfers, beveled shoulder and shoulder margin configurations. The angles at margins were 20°, 45° and 90° to represent beveled shoulder, chamfer and shoulder designs respectively. Each die was used as a master model for production of castings using 5 different type of base metal alloys (Jelanco O, Cameo, Olympia, Jelstar and Genesis II). The abrasives were aluminium oxide (15-45 μ) and glass beads (40-80 μ). **Vahidi and colleagues**^[18] evaluated the marginal adaptation of all-ceramic crowns and metal ceramic crown systems. They selected twenty two recently

extracted premolars for the study. Twelve teeth were selected for the Renaissance crowns (William Gold Refining Co. Inc., Buffalo, N.Y.) and five for Dicor crowns (The marginal adaptation of Renaissance crowns was compared with that of widely used metal ceramic and Dicor crowns (Dentsply International Inc.) and five were bevelled to receive Metal ceramic crowns. **Kern and coworkers**^[19] clinically evaluated the influence of two trituration capsule cement systems on the marginal fit of inner copings for telescopic crowns. Using a randomized parallel design study, one coping was cemented using zinc phosphate cement (Phosphacap) and one using glass ionomer cement (Ketac-Cem Maxicap) for each patients. The result of this study was that the mean marginal discrepancies for all cast copings were approximately 30 (μm) before cementation, and increased significantly after cementations to 86 (μm) in the zinc phosphate copings but to only 47 (μm) in glass ionomer cement copings. **Piemjaj and others**^[20-21] conducted an in vitro study to determine the effect of seating force, margin design, and cement on marginal seal and retention of complete metal crowns. They prepared Crowns with 3 finish lines- chamfer, shoulder and shoulder with a 45° on a dentoform premolar. **Yeo and colleagues**^[22] conducted a study to compare the marginal adaptation of single anterior restoration made using 3 different systems of porcelain crowns. The in vitro marginal discrepancies of 3 different all ceramic crown systems (Celay In-Ceram, conventional In-Ceram and IPS Empress 2) and a control group of metal ceramic restoration were evaluated and compared by measuring the gap dimensions between the crowns and the prepared teeth at the marginal openings. They concluded that the marginal discrepancies were all within the clinically acceptable values set at 120 μm . **Jahangiri and associates**^[23] assessed the effect of preparation design on marginal adaptation. In addition, they also evaluated the sensitivity and specificity of clinical evaluations of marginal adaptations of cast restorations which was compared by stereomicroscopy. Three Ivorine molar teeth of differing designs were prepared: Group I consisted of a complete crown preparation with a chamfer finish line, Group II consisted of complete crown preparation with a buccal shoulder and beveled finish line, and Group III consisted of a three-quarter crown preparation with proximal boxes and beveled finish line. Twenty-four castings (n = 8) were waxed and cast using alloy with a composition of 12% silver, 67% copper, and 20% zinc (Ney technique casting metal; Degussa-Ney Dental Inc), twelve circumferential sites were identified for examination on each casting using a stereomicroscope, which were interpreted using a software (Bioquant 98). **Rathod**^[24] investigated and compared the validity of ringless investing- system for marginal fit of the copings and the conventional-metal ring- investing system. To standardize the study, 40 copings were directly

fabricated on a metal die (Maxillary premolar) and were segregated into two main groups. Group I (n=20) were invested with conventional metal-ring- investing system and Group II (n=20) were invested in the with ringless system.

Lacy and others ^[25-26] evaluated the three factors which affect the investment setting expansion and casting size. They recognized the major variables of casting as number of liners in the ring, position of liners, position of wax pattern in the ring and water/powder ratio of investments; and they conducted a study to evaluate the effect of a. mixing rate, b. ring liner position and c. storage condition on the setting expansion of both gypsum bonded and phosphate bonded investment molds and subsequently relate casting size with measured expansion data. **Dean** ^[27] studied the effect of two-step ringless investment technique on alloy castability. The purpose of their study was to evaluate the effect of two-step ringless partial denture investment technique on castability of a base metal crowns and fixed partial denture alloys. No significant differences were found between the control technique and experimental techniques at the same mold temperature, However, significant difference were found between castings made by the two casting units at a temperature of 1250° F. **Takahashi and others** ^[28-30] and associates developed a new device for measuring the setting expansion of phosphate bonded investment and assessed the effect of different pattern materials on the internal setting expansion. Three pattern materials were soft inlay wax, hard inlay wax, and autopolymerizing resin. Standard crown type patterns were prepared for all the materials on a custom designed metal die and invested patterns were subjected to testing. **Lombardas and coworkers** ^[6] evaluated the dimensional accuracy of castings produced with ringless and metal ring investment systems. On a metal die 30 copings were made and divided into 3 groups of 10 copings. For the first and third groups metal ring was used for investing and casting. In the first group metal ring with 2.5 cm diameter and a ceramic line paper (Bego) which was wetted for 1 minute used. In the third group metal ring along with ceramic paper liner (Bego) was used according to manufacturer's instruction, whereas for the second group, a ringless system was used. **Souza and others** ^[31-32] conducted an in-vitro study to compare the vertical marginal accuracy of single full coverage metal restorations, between ring-less and metal ring investment techniques, using two different types of phosphate bonded investment materials, for implant supported fixed dental prosthesis. Three groups were made of ten samples each. Group I consisted of a metal ring with PCT Flex Vest (phosphate bonded investment material). Group II consisted of a metal ring with Bellasun phosphate bonded investment material. Group III consisted of a ring-less investment system and Bellasun investment material. The wax patterns were prepared on a metal die, cast and finished.

CONCLUSION

Alloys with high Gold content are found to produce excellent esthetic and functional results when used for ceramometal restorations. Marginal fit is one of the most important factors for the success of any restoration. Retention of plaque can lead to both marginal inflammation as well as gingival recession. Insufficient marginal fit can cause caries and secondary caries below the margins of the crown thus; vertical and lateral deficiencies at the margins of restorations often lead to periodontal breakdown resulting in tooth loss. Since the fit is dependent on so many factors. It is mandatory to follow sound production for fabrication of accurately fit castings. ^[33-42]

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