# MISFIT PROFILE OF DENTAL BRIDGES

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***ABSTRACT***

*Clinical evidence has shown that dental bridge (DB) misfit is more frequent than individual crown restoration misfit, and that it causes restorative failures.*

*A comparative study of misfit profiles was performed for the most common clinical situations in mouth rehabilitation procedures with fixed restorations: gold-cast DB and porcelain metal alloy DB.*

*Evidence from this study may lead dentists to consider the advantages and weaknesses of one structure type over the other. The results obtained showed two different profiles, with the porcelain metal alloy (PMA) DB being less predictable than the gold-cast DB. The posterior abutment restoration tends to come apart distally from the tooth structure and get closer to the mesial aspect, while keeping distal-medial separation with respect to the anterior abutment.*

*The gold-cast DBs showed a separation pattern in which the distal end comes away from the molar and the medial end from the premolar, getting clearly closer to the faces next to the pontic: its distal aspect gets closer to the premolar and mesially to the molar. The study has also shown that even though the adaptive patterns are different, is less in PMA than in gold alloys, the latter being used only in a small percentage of clinical indications in oral rehabilitation, mainly due to aesthetic demands and high costs.*

*The impact of this research in clinical dentistry is that PMA DBs have shown worst marginal adaptation areas where clinically, there is lack of vision or inaccessibility for appropriate dental preparation.*

*Key words: Prosthodontics, Fixed bridge marginal adaptation, Gold alloys, Porcelain-metal alloys, Scanning electron microscopy.*

## PERFIL DE DESADAPTACIÓN DEL PUENTE ODONTOLÓGICO

***RESUMEN***

*Ante la evidencia que los puentes odontológicos (PO) desadaptan más que las restauraciones individuales y que la desadaptación en prótesis fija es un factor determinante del fracaso, se llevó a cabo un estudio comparativo del perfil de desadaptación de los PO más utilizados en rehabilitación bucal: el PO colado en oro y el colado en aleación no preciosa y porcelana fundida.*

*A partir de este, podemos trasladar al clínico las ventajas y debilidades de un tipo de estructura con respecto a la otra. Los resultados obtenidos muestran dos perfiles diferentes, presentando el PO ceramometálico un comportamiento más desordenado que el colado en oro, la restauración del pilar posterior se separa de la pieza dentaria por distal, se acerca por mesial y mantiene esta separación en distal y mesial del pilar anterior.*

*El PO colado en oro se separa en los extremos, distal del molar y mesial del premolar y se acerca marcadamente en las caras vecinas al tramo, distal del premolar y mesial del molar.*

*Ha quedado también demostrado que el comportamiento adaptativo, a pesar de ser diferente, es menor en las aleaciones no nobles con porcelana fundida con respecto a la aleación de oro, relegadas estas últimas, a un bajo porcentaje en su uso clínico en rehabilitación, debido a la demanda estética y los altos costos.*

*El impacto de este trabajo en la clínica consiste en que el PO ceramometálico ha desadaptado más en las áreas donde su confección en boca es más dificultosa por su visión e inaccesibilidad.*

*Palabras clave: Prótesis, Puente fijo, Adaptación marginal, Aleación de oro, Aleación porcelana y metal, Microscopia electrónica de barrido.*

## INTRODUCTION

The fit of fixed bridge restorations is a major issue in prosthetic rehabilitation. Dental bridges (DBs) have more clinical problems than individual crown restorations because the misfit of one abutment [1] is inevitably transmitted to another, bringing about a synergy of errors.

Many resources have been used in the search to correct this geometrical consequence, some more successfully than others, e.g. internal grinding with contact detection materials, casting the structure in two parts and soldering them with conventional hot soldering, casting in one piece, cutting with ultrafine disks and soldering with conventional or

laser powered soldering and through the use of vertical and horizontal attachments[2-3].
In order to quantify the misfit, literature tends to look into the intrinsic properties of the building materials[4], casting techniques[5] and type of cervical finish-lines[6-7]. Historically, misfit has been measured in an imprecise, intuitive way using methods such as periapical x-rays[8] and the inflammatory responses of periodontal tissues[9]. In clinical practice, misfit is "evaluated" by using explorers, according to the gap or discontinuity around the restorations, though it is clear that even the best explorer is thicker than the range of the gap that can be expected to be measured[10].
Although the results thus obtained quantify the misfit, they do not establish a repeatable, expectable misfit profile that could be applied to the clinical decisions taken by the operator.
The advantage of knowing the misfit of the different types of cast structures for the DB is that the clinician would be aware of the different outcomes that could be expected for the final restorations, in particular, the well-known irreversible damage caused by misfit to the tissue structures supporting and surrounding it[11-12].
As no precise scientific confirmation with immediate clinical application of DB fit patterns for gold-cast or porcelain metal alloy (the most frequently used materials) was found in the literature, the aim of this study is to establish the misfit profile for dental bridges made from these materials.

## MATERIALS AND METHODS

Fourteen dental bridges (DBs) were made with abutment heads in teeth 1.4 and 1.6, replacing tooth1.5, and symmetrically in the contralateral quadrant, involving teeth 2.4, 2.5 and 2.6. Seven were cast in gold alloy (Midas - Jelenko Corp.) and the other seven in porcelain-metal alloy with non-noble alloy (Wiron® 99 – Bego Dental) fused to porcelain (Creation® - Willi Geller).
The following technique was used to prepare the samples:

- An elastomeric impression was made of the upper maxilla of a fully dentate patient and used to prepare 7 working models upon which the 14 abovementioned bridges were made.

- For the DB abutments, we used fresh natural teeth: third molars extracted from the wrong position and premolars extracted for orthodontic purposes (preserved in saline physiological at 4ºC with 2 % nystatin as an antifungal). They were placed in the positions of teeth 1.4, 1.6, 2.4 and 2.6 respectively. Premolars were used to replace teeth 1.4 and 2.4; and molars to replace teeth 1.6 and 2.6. The spaces for the two second premolars (1.5 and 2.5) in the elastomeric impression of the mouth were filled with silicone.

- One premolar and one upper molar were placed in the elastomeric impression in the negative shapes of 1.4, 1.6, 2.4 and 2.6. When crown anatomy made it necessary, the shape in the model was enlarged with a scalpel. Teeth were fixed with utility wax to the impression, in positions that were as parallel as possible. Small grooves were made in the roots, perpendicular to their main axis, to ensure that they would be mechanically fixed during subsequent steps.

- The roots of 1.4 and 1.6, and the roots of 2.4 and 2.6 were splinted together using a wire looped between them, to which self-curing low-contraction resin (Duralay® - Reliance. Dental Mfg.co) was added. The aim of the splinting was to provide stability to the set of teeth + bridge upon removing from the plaster working model to be cut and measured.

- The elastomeric impression with the teeth in position and splinted roots was filled with densite plaster (type IV).

- After opening the model, a single operator performed the rational preparations on the abutments, with the parallelism needed to allow the subsequent placing and removal of the cast structures of the DBs. Waxing was used to imitate the periprosthetic gum in order to provide conditions similar to those in the oral cavity for the subsequent impression to be taken (Fig. 1).

- The same operator took impressions with Elite brand silicone (Zhermack SpA, Italy) with putty consistency in the tray, medium consistency applied with a self-mixing syringe on the putty, and fluid consistency applied on the preparations with a syringe and fine point (one-step technique). Rigid, non-perforated Rim-Lock trays were used with the appropriate adhesive for the elastomer used.

- Type IV Whip-Mix plaster (densite) (Prima Rock® - yellow color) was used to fill the impressions.

- The 14 metallic structures were waxed and cast (7 gold and 7 PMA). Porcelain was applied to the PMA structures in six firings: metal oxidation, two firings for the opaque, one for the dentin, one for the enamel and the last one for glazing (Fig. 2).

- The DBs were cemented using Hoffman´s phosphate cement (Dental Manufaktur – GmbH – Berlin), under five minutes' mechanical pressure using a small, simple vise to hold the model from beneath and the bridge occlusally. To unify the force, a piece of ethylene vinyl acetate 1mm thick was placed between the occlusal face of the bridge and one of the active arms of the vise, which was tightened until the parts made contact, and after the first contact it was adjusted with two full turns of the wing nut of the press.

- When the cement had set, the excess was removed and it was left for 24 hours. The plaster model was cut mesially and distally to the respective bridges and under the roots (Fig. 3). All the surrounding plaster was removed in order to uncover the root splinting (Fig. 4).

- Grooves were made occlusally to the DBs using ultrafine disks (Jelenko 25 Jel-thin 9's) in mesiodistal direction to guide subsequent cuts using the slow-speed saw (IsoMet®). These grooves were made in the parts of the restorations where measurements would be taken (Fig. 5).

- Rectangular boxes were made from pink wax, into which the cemented DBs with splinted roots were placed. Transparent self-curing acrylic resin (Subident® - Subiton Laboratories SA) was poured into the wax boxes to contain all the parts. As the resin was transparent, it allowed direct viewing of the lines marked on the DBs to be cut subsequently with the saw (Fig. 6).

- The faces of the transparent resin prism were polished to make it easier to see the places where the metal structures would be cut. Once they were visible, they were marked with red indelible ink on the outside of the acrylic prism (Fig. 7).

- The slow-speed saw was used to make a cut in mesio-distal direction, taking the two abutment heads and the pontic (Fig. 8).

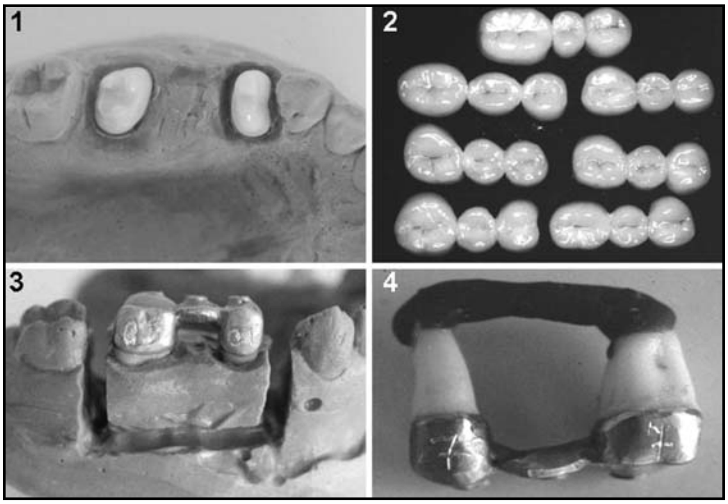


*Fig. 1-4: 1. Rational preparations on abutment teeth 1.4 and 1.6. 2. Finished PMA Bridges. 3. Sections of the plaster model to remove the cast structure; 4. Splinted roots uncovered after removing the surrounding plaster.*

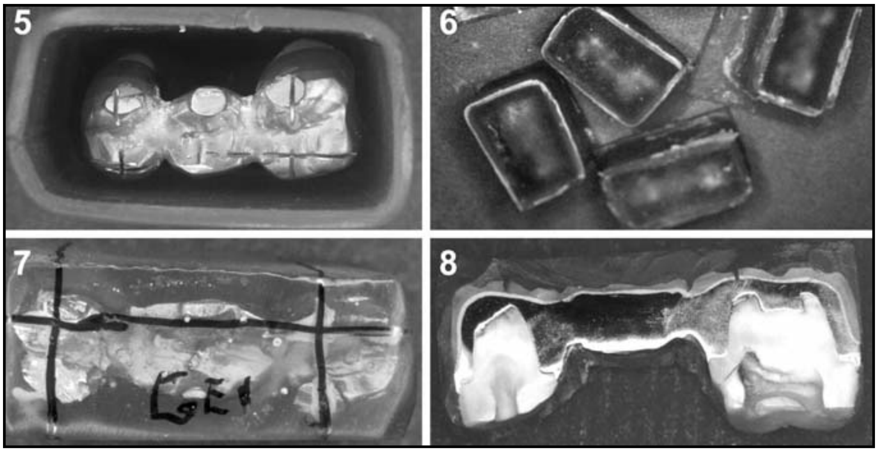


*Fig. 5-8: 5. Grooves made with ultrafine disk to guide cuts with the slow-speed saw; 6. Structures embedded in acrylic resin to be contained during cutting. 7. Marks on the resin prime to guide the path of the saw. 8. View of the mesio-distal section taking abutment heads and pontic.*

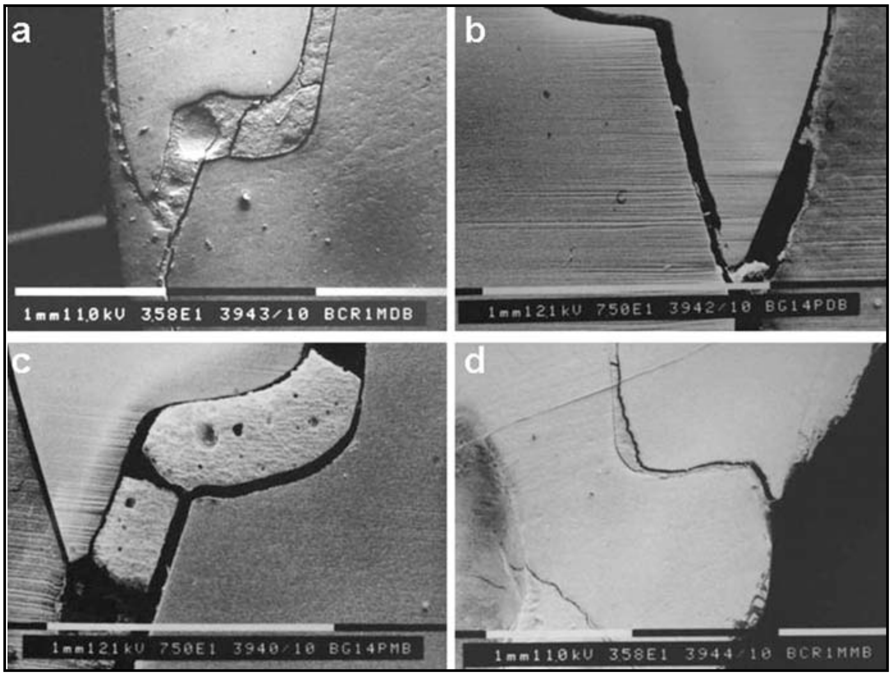


*Fig. 9: ESEM microphotographs. Interface between metal structures and teeth were measured.*

- Environmental scanning electron microscope (ESEM) was used to measure the interface between the metal structures and the teeth (Fig. 9) at the following areas or points: Bevel (B), Cavosurface (CS) and Shoulder (S), both mesially (M) and distally (D) to premolars and molars (Fig. 10). We shall call this set of measurements *Misfit Profile*. The measurements are expressed in microns.

## STATISTICAL PROCESSING

Data were analyzed using Statistix® Analytical Software. The assumption of normality of the samples was evaluated by means of the Shapiro Wilk test and Student's t test for independent samples was performed (for homogenous or heterogeneous variances, as relevant). Significance level was set at $\alpha = 0.05$ and power level at 0.80.

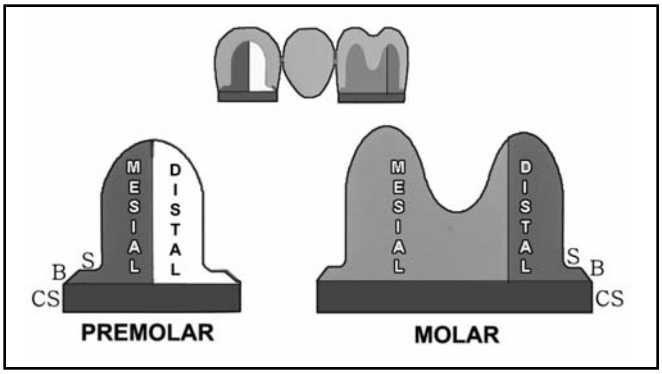


*Fig. 10: Areas measured on the respective DB abutment teeth.*

## RESULTS

The results obtained are shown in Figures 11 and 12.

Misfit averages according to area and samples are shown in Table 1.

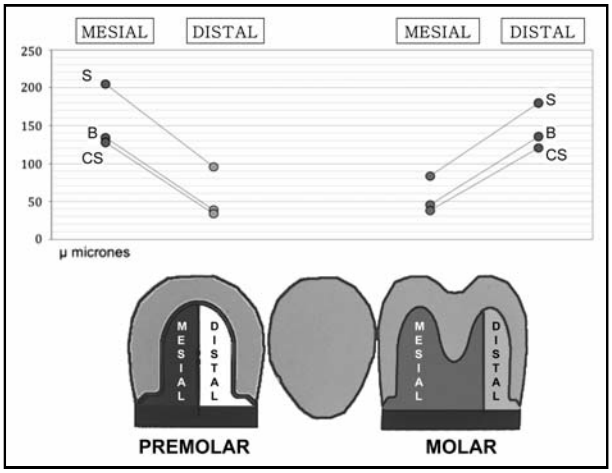


*Fig. 11: Graph showing gold-cast DB misfit profile.*

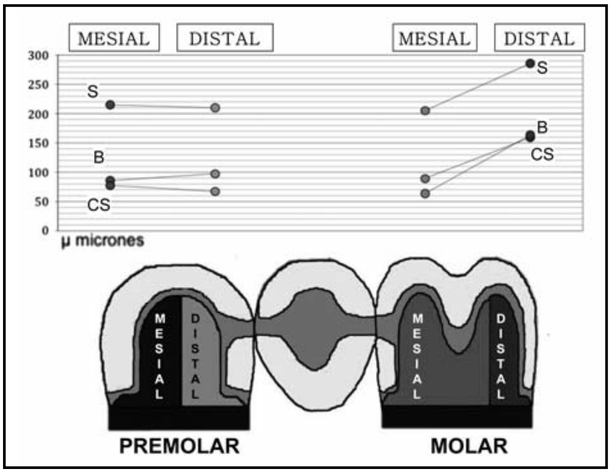


*Fig. 12: Graph showing PMA DB misfit profile.*

**Table 4: Comparison of average misfit between CSM-CSD; SM-SD; BM-BD in premolar and molar tooth of gold-cast and PMA DBs (n = 7).**

| DB Type | Tooth | Difference | Area | Average (μm) | Standard Deviation | Statistical Test (t=) | p-value |
|---|---|---|---|---|---|---|---|
| GOLD | Premolar | CSM-CSD | CSM | 132.14 | 66.63 | 3.87 | 0.007* |
| | | | CSD | 34 | 7.87 | | |
| | | SM-SD | SM | 205 | 64.8 | 3.92 | 0.002* |
| | | | SD | 95.71 | 35.1 | | |
| | | BM-BD | BM | 134 | 57.1 | 4.32 | 0.004* |
| | | | BD | 39 | 11.48 | | |
| | Molar | CSM-CSD | CSM | 38 | 15.48 | 2.57 | 0.04* |
| | | | CSD | 120.7 | 83.64 | | |
| | | SM-SD | SM | 83.57 | 31.58 | 1.66 | 0.14 |
| | | | SD | 180 | 150.4 | | |
| | | BM-BD | BM | 45.71 | 18.12 | 2.56 | 0.04* |
| | | | BD | 135.71 | 91.07 | | |
| PMA | Premolar | CSM-CSD | CSM | 77.14 | 41.41 | 0.53 | 0.607 |
| | | | CSD | 67.14 | 28.26 | | |
| | | SM-SD | SM | 215 | 63.31 | 0.13 | 0.895 |
| | | | SD | 210 | 75.71 | | |
| | | BM-BD | BM | 85.71 | 52.23 | 0.52 | 0.615 |
| | | | BD | 97.14 | 26.43 | | |
| | Molar | CSM-CSD | CSM | 63.57 | 30.37 | 2.5 | 0.04* |
| | | | CSD | 163.57 | 101.27 | | |
| | | SM-SD | SM | 205 | 97.68 | 1.35 | 0.2 |
| | | | SD | 285 | 124.48 | | |
| | | BM-BD | BM | 89 | 48.75 | 1.46 | 0.18 |
| | | | BD | 159.29 | 118.09 | | |

CSM: Cavosurface Mesial; CSD: Cavosurface Distal; SM: Shoulder Mesial; SD: Shoulder Distal; BM: Bevel Mesial; BD: Bevel Distal
* significant for $p \leq 0.05$

## DISCUSSION

PMA and gold-cast DBs have different misfit profiles.

For gold-cast DBs we found a very close fit for the faces near the edentulous gap and a significantly greater misfit for the faces far from the gap. The free vestibular and lingual faces had an intermediate misfit. It may be concluded that the greatest misfit mesially to premolars and distally to molars is due to a pattern of contraction that "fixes" the mid-section of the bridge and separates the ends.

For PMA DBs, the pattern shows an even misfit for all areas of the premolar and the mesial surface of the molar, and significantly greater misfit for the distal surface of the molar.

The error generated by this type of misfit is very important clinically because it is more difficult for the dentist and the patient to check and clean distal areas in the oral cavity.

PMA DBs are the type most often used nowadays, and their misfit profile produces a greater error on the distal surfaces of molars.

In addition, this is the most difficult area to view, work here is performed under indirect vision and lighting, the molars in the upper maxilla have the narrowest bone septum, i.e. an exiguous interproximal space which is difficult to access. All this creates difficulty in preparation, prosthetic impression, checking during the test and installment procedures, and once installed, removal of cement and patient hygiene. Our working model did not involve these clinical difficulties, but it should be considered they will be exacerbated in patients by the misfit profile found in the study.

Gold-cast three-piece bridges are seldom used nowadays on the local market for two reasons: the great demand for esthetics and its high cost. Their misfit profile is worse on the proximal surfaces distant from the pontic (mesially to the premolar and distally to the molar), which also compromises the critical area described above for the distal surface of the posterior abutments, in our case the molar. Individual tooth misfit has already been studied and contrasts with the problems found in this study for DB misfit profile, pointing to the clear need to use strict scientific methodology for studying the adaptive behavior of bridges cast in two pieces with connections, which, after they are cemented, provide greater precision and durability.

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