

One-piece casting for fixed bridgework

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ABSTRACT—A laboratory technique suitable for one-piece casting of short or long span bridges and its application to a seven-unit one-piece cast bridge is described.

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Introduction

The advent of the indirect technique for the construction of cast restorations initiated a move to one-piece cast bridges.^{1, 2, 3}

A one-piece cast bridge when constructed by drawing the wax pattern from the model, invested, and cast, may "rock" on the abutment preparations of the master die resulting in poor marginal adaptation. Because of this, it is preferable to make the bridge in two or more parts, taking an intra-oral record of the parts and soldering the bridge in the laboratory.

However, soldered connectors inherently have more undesirable properties than cast connectors. These include reduced strength,⁴ increased corrosion,⁵ greater post-joining distortion of the bridge, poorer marginal

adaptation,^{6, 7} and longer construction time.⁸ Also, for ceramo-metal post-veneered restorations, the porcelain cannot be altered⁸ by firing after the units are soldered without destroying the bridge. Furthermore, the correct width of a solder gap for purposes of strength is open to debate.^{4, 9}

Errors arising in joining a bridge by soldering have been attributed to solder shrinkage upon cooling,³ occlusal indexing and soldering investment,⁶ the pressure caused by metal expansion which is greater than the expansion of soldering investment when heated,⁵ and possible warpage¹⁰ of pre-veneered soldered ceramo-metal bridges during several firing cycles.

¹ Penzer V. Fixed bridges without soldering. *J Pros Den* 1953; 3:718-20.

² Bruno SA. One-piece fixed bridge. *J Pros Den* 1955; 5: 401-7.

³ Rubin JG, Sabella AA. One-piece castings for fixed bridge-work. *J Pros Den* 1955; 5:843-7.

⁴ Tylman SD. Theory and practice of crown and bridge prosthodontics. 5th ed. St. Louis: CV Mosby, 1965: 1185-95.

⁵ Skinner EW, Phillips RW. The science of dental materials. 6th ed. Philadelphia: WB Saunders, 1967:558, 564.

⁶ Huling JA, Clark RE. Comparative distortion in three-unit fixed prostheses joined by laser welding, conventional soldering, or casting in one piece. *J Dent Res* 1977;56: 128-34.

⁷ Fusayama T, Wakumoto S, Hosoda H. Accuracy of fixed partial dentures made by various soldering techniques and one-piece casting. *J Pros Den* 1964;14:334-42.

⁸ Miller LL. Framework design in ceramo-metal restorations. *D Clin North Am* 1977;21:711, 713.

⁹ Rasmussen EJ, Goodkind RJ, Gerberich WW. An investigation of tensile strength of dental solder joints. *J Prosthet Dent* 1979;41:418-23.

¹⁰ Hoffman EJ. Alternatives to gold alloys in Dentistry. Maryland: Dhew Publications, 1977:205.



Fig. 1.- Production of retainer copings using plastic **Adapta** blank.

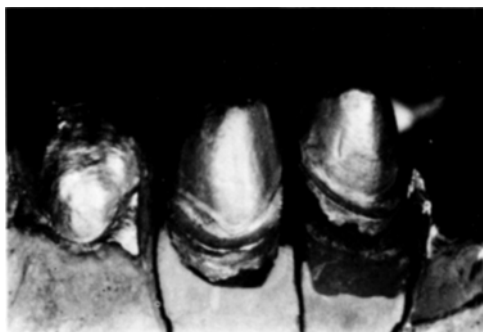


Fig. 2. Trimmed plastic blanks on abutment models prior to waxing the margins with soft burnishable wax.

Where a one-piece cast bridge does "rock" on a master die, the most likely cause is the bending and distortion of the long wax pattern as it is drawn from the model prior to investing and casting. In view of this a working technique has been developed to improve the rigidity of the bridge wax pattern.

Technical procedures

The impression is silver-plated and precision screw dowel pins* used in the construction of the model. The upper and lower models are related with two intra-oral acrylic records† taken at the centric occlusion position and average settings used for condylar guidance and Bennett angle on the articulator. A customized incisal table is not prepared as the anterior guidance is developed intra-orally. The prescription for the occlusion is, where possible, an anterior and posterior group function, avoiding all non-working side contacts.

The components of a bridge wax pattern prior to spruing are retainer copings, connectors and pontic. They are reinforced as follows.

Each of the retainer copings are made from a transparent 0.6 mm thick plastic blank‡ which is positioned in a hand clamp and heated over a bunsen flame until uniformly softened. With the blank held over a container of moulding putty, each abutment die is plunged incisal or occlusal surface first, through the blank into the putty (Fig. 1). After cooling, the die with the blank attached is removed from the container of putty and the blank teased off the die so that it can be trimmed with a pair of scissors.

The plastic coping is trimmed 1 mm short of the cavo-surface margin so that when placed back in the die the cavo-surface margin and 1 mm of the adjacent axial wall of the die is exposed (Fig. 2). A thickness gauge is used to measure each plastic coping in the range 0.3 and 0.5 mm, and, to any areas that are thinner, wax is added to achieve an optimal thickness range. The cavo-surface margins and adjacent exposed axial wall are waxed to the coping with soft burnishable wax.§ The wax margins are closely examined with magnifying

* G. M. Ney Co., Blomfield, Connecticut, U.S.A.

† Duralay, Reliance Dental Mfg. Co., Detroit, Michigan, U.S.A.

‡ **Adapta**, Bego Bremer Goldschlagerer, Bremen, West Germany.

§ **Gebdi wax**, Gebr. Ditzel GmbH, Meckesheim, West Germany.

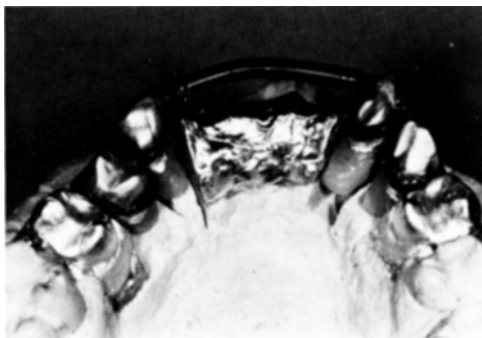


Fig. 3.—Palatal view of the linked retainer copings with waxed margins and 10 gauge acrylic stick spanning pontic region connected to retainer copings 13 and 22.



Fig. 4.—One piece casting checked for correct adaptation to model and abutments. Note the marginal accuracy.

loops ($\times 2.5$) and wax that has retracted from the cavo-surface margin on cooling is burnished with a cold blunt-tipped Le Cron carver. Prior to linking the retainer copings, the model is cleaned and the precision screw dowel pins tightened.

The connectors between the copings are fabricated with auto-polymerizing acrylic resin, and, to aid in the adhesion to the coping, the surface is freed of wax and roughened with a steel bur. An acrylic stick[†] (10 gauge) is used to start off the pontic span. This stick is heated over a bunsen burner, hand moulded, and occlusion checked for freedom in all excursions prior to joining the stick to the completed retainer copings of the 12 and 13 with resin (Fig. 3). The stick is then used as a starting line to "drop" the wax to complete a modified ridge lap pontic design.

The sprue system, designed to minimize casting porosity, includes short length (2-3 mm) flared^{††} ingate

sprues (10 gauge), a single long runner (8 gauge), three long downshoots (8 gauge) and a large button of similar size to the bridge pattern. A phosphate[‡] bonded thermal expansion investment technique with undiluted silica sol liquid is used so that the desired thermal expansion for accurate and smooth cast margins¹² is achieved.

The bridge is cast in a centrifugal casting machine using a veneering gold alloy.^{**} The cleaned casting, visually free of porosity, is fitted on the dies and its seating carefully assessed with magnifying loops ($\times 2.5$) (Fig. 4).

Case report

(a) Examination and treatment planning

A woman, aged 26 years, was dissatisfied with the existing cobalt-chromium partial denture replacing 11, 12, and 21 (Fig. 5).

[†] Whip-Mix Corporation, Louisville, Kentucky, U.S.A.

^{**} Degudent Universal, Degussa Co., Frankfurt, West Germany.

[‡] Bego Bremer Goldschlagerei, Bremen, West Germany.

^{††} Asgar K, Peyton FA. Pits on inner surfaces of cast gold crowns. J Pros Den 1959;9:448-56.

¹² Cooney JP, Doyle TM, Caputo AA. Surface smoothness and marginal fit with phosphate-bonded investments. J Prosthet Den 1979;41:411-17.



Fig. 5.—Removable partial upper denture replacing 11, 12, and 21.



Fig. 6.—Base plate used for checking aesthetic arrangement of the pontic teeth and determining the location of displacement forces. Lever arm, A; fulcrum line, B; line of resistance, C; and the resistance arm, D: required to prevent anterior displacement of the bridge.

Detailed oral examination included a functional occlusal analysis which revealed a 14 guided lateral occlusion on the right side; a 22, 23, 24, 25 guided lateral occlusion on the left side; disclusion of the posterior teeth by the 11 and 21 in protrusion; and a coincidental centric relation and centric occlusion position free of any temporomandibular joint and muscle pain or dysfunction.

A diagnostic set-up of the missing anterior teeth was tried in so that the patient would assess the aesthetics of the simulated pontics (Fig. 6). The number of retainers required to prevent anterior displacement of the bridge was decided after examining the study models. The length of the longest lever arm was determined and posterior abutments included until the resistance arm was greater than the lever arm. After assessment of the anticipated retention form of the abutments and of the occlusion, a seven-unit fixed-fixed ceramo-metal bridge was designed with retainers on the 13, 14, 22 and 23.

(b) Preparation and temporization

At the first preparation appointment, 22 and 23 were prepared and temporized with polycarbonate shells^{††} lined with acrylic resin and cemented with zinc oxide-eugenol cement. This allowed the patient to use the existing partial denture. The 13 and 14 were prepared at the following appointment, and an acrylic temporary bridge, as described by Kaiser,¹³ was constructed and cemented with the zinc oxide-eugenol cement (Fig. 7).

(c) Impression

At the next appointment, the preparations were refined and a full arch polysulphide impression was taken using a modification of a "retained" retraction cord

^{††} Ion Co., Costamesa, California, U.S.A.

¹³ Kaiser DA. Accurate acrylic resin temporary restorations. *J Prosthet Dent* 1978;39:158-61.



Fig. 7.—Temporary acrylic bridge.



Fig. 8.—Upper and lower models related with **Duralay** records taken intra orally on 14 and 23 in centric occlusion.

technique.¹⁴ This required the placing of a thin retraction cord into the base of the gingival crevice followed by a second cord to complete the retraction of the gingiva, so that the cavo-surface margin of the abutments were just exposed. Only the superficial cord was removed prior to injecting the light body impression material.

(d) Technical procedures

The technical procedures as described above were used for the production of models, and casting of the bridge and abutments. Figure 8 shows models mounted in centric occlusion.

(e) Try-in and cementation

The casting was tried in so that all bridge margins could be checked for adaptation to the abutments. The marginal fit was judged excellent, the internal fit was passive. Care was taken at this appointment to ensure that the inciso-axial angles of the 11, 12, 13, 21, 22 and 23 casting were adjusted so that in lateral excursions there would be sufficient thickness of porcelain to produce the desired anterior group function and aesthetic effect.

The bridge was tried in after ceramic veneering, examined, and appropriate adjustments made for aesthetics, occlusion, contact areas, gingival and mucosal relationships. A favourable anterior guidance free of steep protrusive and lateral rises was produced against the porcelain surfaces of the bridge with the aid of foil^{‡‡} for the identification of tooth to porcelain contacts. The protrusive occlusion achieved was edge to edge contact of 11 and 21, with concomitant posterior and remaining anterior disclusion (Fig. 9). The bridge was cemented using zinc-oxide eugenol cement and **Vaseline** ("soft cementation") so it could be removed at the next

appointment for possible aesthetic or functional adjustments before final cementation.

The patient returned after three days and no adjustment to the bridge was required. At this appointment, the patient was instructed on how to clean daily under the bridge with dental floss using a threader^{§§} to enter the floss below the pontic and between connected retainers. The bridge was removed and cleaned, glazed (autogenous) and permanently cemented with zinc phosphate cement.

Discussion

This laboratory technique has been used successfully in the construction of fifty bridges at the University of Queensland Dental School, of which three were seven-unit cast spans. The use of this one-piece casting technique simplified the fabrication of these seven-unit bridges and resulted in bridges free of "rock" on the model and abutment teeth with concomitant excellent marginal adaptation.

There are prerequisites for this one-piece casting technique. These include only drawing a bridge pattern from crown preparations that are aligned to each other, macroscopically "smooth", and free of undercuts. It is imperative that no attempt should be made to flex a bridge pattern over undercuts and ease the casting in the hope of a fit. Technicians are otherwise best advised to make the bridge in two or more parts, and to solder rather than to attempt a one-piece casting.

For optimal strength, a one-piece casting is the method of choice in the region of high bending moments⁴ (centre of span) and combined high bending moments and torque⁴ (connectors adjacent to the pontic). In general, the connector between double abutments does not undergo high bending moments or torque compared with the span centre or connectors adjacent to the pontic.⁴ Consequently, if there is a need for solder

‡‡ G. H. M. foil. Hanel-Medizinal, Nürtingen, West Germany.

¹⁴ Roberts DH. Fixed bridge prostheses. Bristol: John Wright & Sons, 1973:206.

§§ Bridge Aid. Floss Aid Corporation, California, U.S.A.

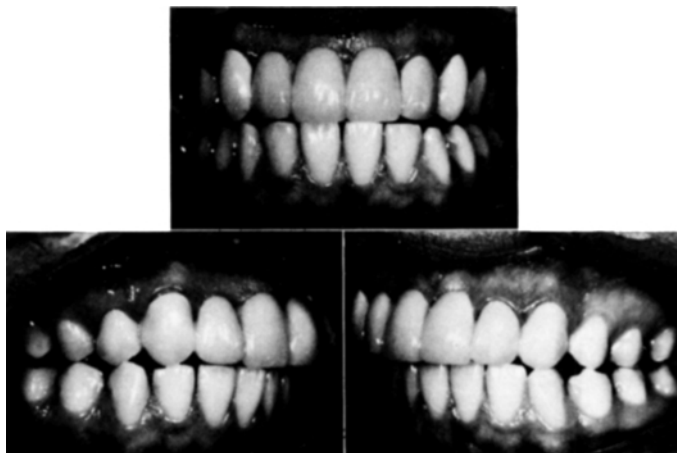


Fig. 9.—Completed restoration 18 months after insertion.

joints in a long span bridge, the connectors of choice for soldering are between the double abutments rather than in the span between the primary abutments.

Shaping the gingival embrasure forms between connected retainers is not a problem with this bridge pattern technique as damage to adjacent wax proximal margins was not possible. This was because the completed retainer copings were connected using acrylic resin and no hot instruments or molten wax were required in the region of the completed margins. A passive internal fit of this bridge to the model and abutment teeth was evident. This simplified the removal and replacement from the preparations intraorally and in the laboratory. This passive internal fit is a common occurrence with the plastic coping technique. Complete reproduction of microundercuts present in the surface roughness of the crown preparations probably does not occur. With a total wax-up technique, microundercuts can easily be copied. On drawing the pattern, wax smears and streaks are evidenced on the internal surfaces of cast restorations.¹⁵ This is probably the major reason why the plastic coping technique consistently produces passive internal fitting castings.

It has been shown that luting crowns which have passive internal fitting surfaces will result in significantly better marginal fit than luting crowns with frictional internal fitting surfaces.¹⁶ Consequently, passive fitting castings produced using this technique have presented no problems in seating with zinc phosphate cement.

It has been suggested¹⁷ that to replace 11, 21 and 12 with a bridge, double abutments on the left side are required with only a single abutment on the right side. Despite this, double abutments on both sides were used to ensure that the resistance arm was greater than the lever arm thus countering incisal leverage. After eighteen months, the occlusion previously created for this patient was stable and the patient exhibited all the characteristics of a healthy stomatognathic system. Emphasis was placed on creating anterior guidance by intraoral adjustment of both the casting and the veneered bridge. The bridge was not premature in centric relation or centric occlusion and provided anterior and partial posterior group function without non-working interferences or protrusive interferences, and without steep protrusive or lateral guidance.

Conclusion

The case report describes a one-piece, cast, seven-unit, ceramo-metal bridge prosthesis which satisfied functional and aesthetic requirements.

A reinforced wax pattern technique suitable for one-piece casting which provides an alternative to either a total wax-up pattern technique or routine soldering also has been described. It produces a strong bridge which favours a passive internal fit with accurate marginal adaptation to the abutment teeth.

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¹⁵ Ostlund LE. Improving the marginal fit of cast restorations. *J Am Acad Gold Foil Oper* 1974;17:56-65.

¹⁶ Darveniza CM. A comparison of the internal and marginal adaptation of full cast crowns as cast, after venting and after electrochemical etching. MDS thesis, University of Queensland, 1980.

¹⁷ Shillenburg HT, Hobo SI, Whitsett LD. Fundamentals of Fixed Prosthodontics. Berlin: Die Quintessenz, 1976:39.