Functionally generated paths for ceramometal restorations

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This article describes a procedure to generate functional path occlusion for ceramometal restorations. With this procedure, the metal framework is formed conventionally, full contour inlay wax is added to the metal framework, and the patient carves functional paths into the wax. These paths are registered with a stone matrix that the ceramist uses as a guide. Advantages over conventional techniques include increased accuracy and simplification of procedures. (J Prosthet Dent 1999;81:33-6.)

Group function occlusion is sometimes beneficial in fixed prosthodontics.[1] These restorations are more clinically demanding than mutually protected occlusal schemes because, if simplified instrumentation is used, semiadjustable or straight line, excessive adjustment is often necessary at insertion. Fully adjustable articulation can be used; however, there will usually be some level of mismatch between the fully adjustable articulator and the patient's mouth.[2,3]

Dentistry has recognized functional path articulations as a viable way of developing occlusion for more than 60 years. In 1933, Meyer[4] described techniques that allow the dentist to use the patient's mandibular movements to carve an occlusal surface. Since then, other authors have refined the method.[5-8] The original Pankey-Mann[9] technique relied on a functional path to create a balanced occlusion.

The following technique is described in *Fundamentals of Fixed Prosthodontics*[10] and is typical of methods used to prepare functional paths:

> Prepare teeth and make a master cast. Make a wax tray over the prepared teeth on the master cast (some authors recommend a cast metal tray). Coat the tray's occlusal surface with a functional wax. Take the tray to the mouth and carefully seat it onto the teeth. Coach the patient to carve the soft wax with movements of his opposing teeth. Chill, box, and seat the tray onto the master cast. Fasten the master cast to an articulator. A simple hinge articulator may be used. Pour the boxed functional path and fasten it to the articulator. Wax prostheses into the stone functional path as desired. Cast the wax pattern, seat the metal prosthesis on the master dies, and refine the prosthesis to fit the stone functional path matrix. (Although the functional path matrix includes centric occlusion areas, some practitioners recommend adjusting the prosthesis into centric occlusion against casts of the opposing teeth.)

Functional path procedures have a reputation for extreme technique sensitivity and difficulty. If one examines the preceding method, the reasons for technique sensitivity become apparent. One must assume the functional path tray will fit the same way on the teeth as it does on the cast. There are small differences between the teeth and casts of the teeth. Furthermore, media used for the tray (acrylic resin, metal castings) are not completely stable. Both problems can lead to a tray that does not fit the teeth precisely the same way as it fits the master die.

Functional wax, which is soft, distorts easily during boxing and handling. Proper handling will minimize distortion; however, the softness contributes to the sensitivity of the technique. Functional wax is not stable. Immediately after the dentist generates the functional path, the technician must pour it in stone. This necessity for close coordination between the laboratory and dentist contributes to the difficulty of the technique. The cast crown must fit precisely the same way on the tooth as it does on the master dies. Otherwise, the functional path will be inaccurate. There will always be slight differences between master dies and teeth. Clinically, it seems possible to achieve exact seating between dies and teeth. However, there will always be some degree of error with this varying from case to case.

There is only 1 stone functional path record. This can become slightly degraded during waxing and adjustment of metal. There is no way for the practitioner to check for degradation. Finally, the use of the opposing stone cast to adjust centric occlusion presupposes that it will be necessary to use the patient's mandibular movements to make final adjustments to the prosthesis.

In many situations, inlay wax works well to generate functional paths. Opposing teeth and prostheses can

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Fig. 1. Preoperative view of missing teeth maxillary right second premolar and canine.

Fig. 2. Conventional full contour wax-up.

Fig. 3. Metal framework with full contour inlay wax added.

Fig. 4. Patient carving inlay wax with functional movements.

work like carvers against this material, giving very accurate functional registrations. There are 3 separate procedures: one for complete dentures and/or removable partial dentures, one for metal occlusion, and one for porcelain occlusion. This article describes a procedure for the porcelain occlusion, which circumvents the previously described problems.

PROCEDURE

The patient whose treatment illustrates the procedure was missing the right maxillary second premolar and canine, and the lateral incisor was in reverse articulation (Fig. 1). The mandibular canine was in reverse articulation to the ridge area of the maxillary canine. A fixed partial denture (FPD) from first molar to canine was planned, with the canine as a cantilever. Because of the missing canine, a group function occlusion was chosen. Steps to fabricate the cast metal framework are equivalent to standard techniques for fabrication of metal ceramic restorations.

1. Prepare the teeth and make an impression.
2. Pin, section, and trim the master casts. In addition, prepare a solid cast.
3. Relate the master cast to the opposing cast by hand articulation or with a centric relation record. Articulate these casts in a semiadjustable articulator.
4. Wax a full contour prosthesis (Fig. 2), and then cut it back for porcelain veneering. (The areas capturing functional movements must be in porcelain. Centric occlusion can be in either metal or porcelain, depending on where these contacts are located. It is often best to keep centric contacts in metal because it minimizes the surface area of porcelain that must be matched to the functional matrix. For this patient, centric occlusion contacts were on the lingual incline of the facial cusp, and the functional path started 0.5 mm from these.)
5. Invest, cast, divest, and seat the prosthesis on master dies. Use the solid cast to verify seating.
6. Prepare the metal for porcelain addition. Carefully adjust centric occlusion and check for excursive interferences.

The technique now diverges from conventional techniques.

7. Reattach the casts to the semiadjustable articulator and replace the FPD framework. If no excursive records were made, use 45 degree condylar settings on each side. If excursive records are avail-

Fig. 5. Stone matrix used for porcelain addition. Second verifying matrix is made.

Fig. 7. Porcelain added to fit stone matrix.

Fig. 6. Relationship of metal framework to stone matrix.

Fig. 8. Completed prosthesis in lateral excursive.

able, increase the condylar angle by 15 degrees. Make a full contour wax-up with inlay wax (Maves Co., Cleveland, Ohio) onto the metal framework (Fig. 3). Adjust wax into group function on the articulator.

8. Seat the metal framework with the full contour inlay wax on the teeth, perfect centric occlusion, and make certain that there are no lingual cusp interferences in excursive movements. Instruct and coach the patient into making protrusive, lateroprotrusive, and lateral movements to carve the wax. (Teeth will carve inlay wax nicely. However, excessive force will break wax off the metal framework.) Continue until the wax and metal prosthesis is in group function with the natural dentition (Fig. 4).
9. When the prosthesis is in group function, return it to the master cast and fasten it with sticky wax. Attach the master cast to the articulator, and replace the opposing cast with a metal stand (Remount Recording Jig, Teledyne Hanau, Buffalo, N.Y.). Paint teeth of the master cast with a stone separator (Super Sep., Kerr Mfg., Romulus, Mich.), place stone on the metal stand, then close the articulator. (The wet stone must contact all the functional areas of the inlay wax. It should also contact the incisal of one tooth mesial and distal to the prosthesis. This will provide a seating guide into the functional path matrix.) Make certain that the stone does not go over the height of contour of the metal and wax prosthesis, or of the natural teeth. Repeat procedure to produce a verifying record.
10. After the stone sets, trim it to allow the technician to easily see functional paths (Figs. 5 and 6).
11. Remove the wax from the framework, and veneer porcelain onto the frame using the stone matrix to guide its placement. The porcelain must precisely fit the areas of the stone matrix representing the functional contacts (Fig. 7).
12. Complete the metal ceramic restorations and check the functional path on the verifying matrix.
13. Seat the FPD on the teeth, verify the occlusion, and cement the FPD (Fig. 8).

With good technique, no adjustment is necessary at insertion.

DISCUSSION

There are advantages of this technique over conventional functional path techniques, the most important

being a functional path tray is not required. Problems associated with the tray, including inaccurate seating and distortion, are avoided. Furthermore, the dentist is not assuming that a prosthesis can be seated the same way on teeth as it does on the master cast. The dentist is only assuming the framework can be seated in the mouth the same on several different appointments. Another advantage is that inlay wax is harder and more resistant to distortion than functional path waxes. Thus, there is less chance of error.

Because the inlay wax is more resistant to distortion, there does not need to be the same level of coordination between laboratory and operatory. Although many prosthodontic practices have a laboratory on premises, it may not be convenient to fabricate stone paths immediately after making the functional path. The relative stability of inlay wax makes the procedure more convenient.

Laboratory procedures are somewhat simplified. The stone matrix of a conventional functionally generated occlusion has many paths, including lateral, medial, and protrusive for both facial and lingual cusps. For a group function occlusion, the dentist may only want facial cusps contacting the working and protrusive paths. Thus, the technician may need to decide which paths to wax to, and which paths to wax away from. In the inlay wax technique, the dentist chooses which path(s) he will use when the metal cutback is performed.

Although this method eliminates many of the problems associated with functional path techniques, it is still a procedure that requires precision on the part of the laboratory and dentist. In particular, the technician must add porcelain to fit a stone matrix. Furthermore, this procedure is only suitable for porcelain occlusion in metal ceramic restorations. Similar methods are available to make functional path occlusion for metal occlusals and removable prosthodontics, but these are more complicated and incorporate some of the errors inherent in conventional techniques.

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