Use of linear occlusion with fixed restorations opposing a mandibular complete denture: A clinical report

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Restoring an edentulous mandibular arch opposing maxillary natural dentition with conventional occlusal schemes historically has proven to be extremely difficult. Using a noninterceptive anterior and posterior occlusal concept with a myostatic peripheral border extent provides a means to enhance stability of the mandibular prosthesis.

Kelly noted that mandibular complete dentures opposing natural maxillary teeth are impossible prosthodontic combinations.1 Historically, this has proven true when the denture has been constructed using traditional techniques and occlusal schemes, due to functional destabilizing forces to the movable prosthesis. These forces are a result of muscle activity during normal function on overextended peripheral borders as well as those generated from eccentric and parafuctional occlusal contacts that result in tipping and rocking of the prosthesis.2 This lack of stability is a constant irritant not only to the tissues but to the patient's psyche as well.14

Following the logic presented by Frush, the development of balanced occlusion with anatomic, nonanatomic, or a combination of tooth forms still would result in tipping or rocking forces when opposing surfaces contact in some method other than centric occlusion.3 Using a noninterceptive occlusal concept and tooth form would prevent lateral dislodging forces from occurring. Linear occlusion has only a straight line of contact to a monoplane surface within a flat, horizontal plane; there are no cusp inclines, depressions, or surface irregularities with which the blade could make contact during the envelope of function (Fig. 1).3 This concept extends the noninterceptive principle to the anterior as well by eliminating contact in protrusion with the bilateral fulcrum of protrusive stability and Christensen's phenomenon.6

Incorporating this bilateral fulcrum is essential for mandibular prosthesis stability. Since the mandible functions by moving forward and upward, contacting immovable teeth in the maxillary arch could result in trauma and resorption of the mandibular residual ridge.7 This lack of anterior contact is accomplished when opposing anterior teeth are arranged using a round, 0.020 in. thick, 3.0 in. diameter, silver template (Geneva Dental Inc., Beverly Hills, CA; 800/436-3827). This set-up template establishes the horizontal plane and ensures a specific amount of anterior separation.

When the mandible comes forward into a protrusive position, a space usually develops between the posterior occlusal surfaces (this is known as Christensen's phenomenon). Vertical overlap of anterior teeth is present and anterior contact occurs with conventional occlusal schemes. With a complete denture, anterior teeth arranged labially in relation to the residual ridge cause a rotational movement of the prosthesis upon contact. Linear occlusion allows the mesial third of the flat occlusal surface of first premolar to provide an edge with which the opposing blade makes contact. Anterior contact is prevented and denture stability is enhanced through this posterior contact and the space provided by the template.

Ramfjord and Ash point out that interocclusal space in the anterior part of a dentate individual's mouth commonly is 1.0–3.0 mm.9 It has become common practice to place marks on the nose and chin of edentulous patients to serve as measurement reference points. Physiologic rest position is determined by one of a variety of methods, including rapid-
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There is a theory that maximum biting force is obtained at physiologic rest position, which would enhance functional efficiency and reinforce the advantage of using physiologic rest position to register vertical dimension of occlusion. It is recommended that centric relation (CR) be recorded as near as possible to vertical dimension of occlusion. Both are positive indications for using an intraoral tracer in the central bearing area to record CR at physiologic rest position.

Another modification to the traditional approach of enhancing stability involves using a myostatic outline to locate the mandibular peripheral border. This technique places the denture border superior to the muscle attachments or in a zone that remains static or immobile regardless of muscle activity. The location of this border is determined and tentatively marked by reading a master cast produced from an overextended, irreversible hydrocolloid impression. This impression is made using special trays designed specifically for this purpose (Accu-Dent System 1, Ivoclar North America, Inc.). The accuracy of the border’s location will be verified intraorally prior to securing the relationship records.

Implants have been suggested as a potential solution to the edentulous mandible by providing support, stability, and retention for the prosthesis but this approach can present other problems, such as undesirable bending moment forces, inadequate quantity and quality of bone for placing implants, inadequate anterior-posterior spread of the implants, an unfavorable risk/benefit ratio, and a considerable additional expense for the patient.

If linear occlusion is used as an alternative approach, it becomes necessary to determine the maxillary and mandibular posterior arch relationships, which is done after the casts have been mounted tentatively on the articulator but before the occlusal surfaces of the fixed restorations are built. The arch relationship dictates whether a blade or a monoplane surface should be built on the posterior restorations.

The position of the occlusal plane also must be established. This position is determined by the incisal edge of the maxillary central incisor in the anterior and the top of the retromolar papilla, as marked previously on either side in the posterior. The maxillary central incisor’s length is dictated by the patient’s esthetic requirements and determined and verified intraorally.

Case report
An elderly female patient required complete reconstruction of her remaining maxillary teeth with porcelain-to-metal restorations opposing an edentulous mandibular arch. The patient declined the option of implants designed to stabilize the mandibular prosthesis and further stipulated that nothing of a removable nature be placed in the maxillary arch.

The patient’s existing complete mandibular denture exhibited badly worn acrylic resin prosthetic teeth in the posterior. The anterior teeth were arranged lingual to the residual ridge in an attempt to compensate for the patient’s Class III skeletal relationship. The occlusal anatomy of the defective maxillary posterior fixed restorations could be described as pseudo-monoplane in design. Due to a mandibular bony malalignment resulting from a previous fracture, the buccolingual width of the maxillary left posterior restorations exceeded normal dimensions to make contact with the mandibular posterior teeth on that side, even though they were arranged lingual to the crest of the residual ridge. The mandibular denture exhibited poor tissue adaptation, resulting in loading instability and buccal and anterior border overextensions, especially in the frenum areas, with excessive mobility during speech and eating. Due to resorption of the residual ridge and occlusal wear of the resin teeth, the vertical dimension of occlusion was overclosed with an excessive amount of interocclusal space with the mandible in rest position.

The patient refused to have the remaining maxillary teeth extracted and a complete denture constructed. She elected to have the existing defective restorations replaced. Having declined any type of bone-anchored implant prosthesis in the mandibular arch, her only option was a conventional complete denture.

The existing maxillary restorations were removed and the teeth were prepared. The existing mandibular denture was stabilized with polyether impression material (Impregum, 3M ESPE, Irvine, CA; 888/364-3577) and a tentative vertical and centric record was made using wax on the occlusal surfaces and a Blue-Mousse wash (Parkell, Farmingdale, NY; 800/243-7446). A mandibular cast was produced from the stabilizing wax and used for mounting in the articulator prior to separating. A tentative occlusal plane was established, using existing central incisor length and the retromolar papillae. An overextended, irreversible
hydrocolloid impression was made of the mandibular arch and the master cast was produced.

The myostatic outline was determined and drawn on the cast; the tissue undercuts within this outline were located and blocked with wax. A stone-separating medium (Iso-K, Geneva Dental) was applied. An autopolymerizing methyl methacrylate resin (C-Plast, Geneva Dental) was mixed and adapted to the master cast. The material was taken to the myostatic outline but not beyond. When the material was polymerized, the approximate position of the distal of the second premolar was marked on either side and a line was drawn to bisect the line indicating the sagittal plane (Fig. 2).

This point of intersection indicated the central bearing point area. Using an extra-hard baseplate wax (Set-up wax, Geneva Dental), the slotted bar of a Vertical & Centric Recorder Kit (Geneva Dental) was positioned on the stable base so that the rounded tip of the vertical adjusting screw was directly over the central bearing point. The bar was positioned at the approximate height of, and parallel to, the occlusal plane (Fig. 3).

To fabricate a maxillary base on which to attach the maxillary recording plate, a second-pour solid cast was made from the final impression of the maxillary crown preparations. The maxillary castings were fitted to this solid cast. The undercuts were surveyed and blocked with wax, allowing the record base to contact the buccal and lingual tissue surfaces as they would when in the mouth (Fig. 4). A resin base (Paladisc LC, Heraeus Kulzer, Armonk, NY; 800/431-1785) was adapted and photocured. A horizontal projection of the photocure material was attached to the buccal aspect of the base near the occlusal surfaces, ensuring that the bases would remain together once the luting impression stone (Plastogum, H. J. Bosworth Co., Skokie, IL; 800/323-4352) had set.

The recording plate was attached at the approximate level of the horizontal occlusal plane, using extra-hard set-up wax. The plate's horizontal position was verified when placed in the patient's mouth with the patient standing erect. The castings were recovered from the solid stone cast and returned to their removable dies. The fit of the base was verified as stable and accurate with the castings in place (Fig. 5).

At the next clinical appointment, the maxillary provisional restorations were removed, the preparations were cleaned, and the castings were inserted using a mixture of Vaseline petroleum jelly (Cheeseborough-Ponds, Englewood Cliffs, NJ; 800/243-5804) and a temporary, non-eugenol cement mix (Nogenol, GC America Inc., Alsip, IL; 800/323-7063). With the patient standing, the recording plate on the maxillary stable base was modified until it was parallel with the horizon. The mandibular stable base was placed in the mouth and adjusted until the attached slotted bar was parallel with the recording plate. The ball bearing-tipped screw was adjusted until the vertical dimension of rest (determined previously with the lips in light contact) was achieved.

After the patient affirmed that the pressure to the residual ridge below the mandibular stable base was uniform and comfortable, a needle point tracing was produced. With the ball tip contacting the tracing's apex, the maxillary and mandibular bases were luted together using quick-set impression stone. The stable bases were removed as a single unit after the stone had hardened. At this point, the castings were removed, the teeth were cleaned, and the provisioningals were replaced. The patient was dismissed after determining an appropriate shade for both the porcelain-to-metal restorations and prosthetic replacement teeth.

The castings were cleaned and returned to their dies and the maxillary recording base was positioned over the castings. The mandibular cast containing the patient's existing denture was removed from the articulator. The new master cast was positioned in its stable base and attached to the articulator. The
maxillary anterior castings were waxed to full contour using buff-colored wax for an esthetic try-in designed to verify length and lip support.

The patient was recalled. The provisional restorations were removed, and the anterior waxed units were placed in the mouth and modified as needed until the desired length and lip support was achieved. The provisional restorations were replaced, the patient was dismissed, and the waxed anterior castings were returned to their dies.

The set-up template was positioned touching the anterior wax incisal edges and the posterior retromolar papilla on either side, establishing the horizontal plane of occlusion. The mandibular anterior teeth were arranged on the stable base with their incisal edges contacting the template's underside (Fig. 6). The monoplane posteriors (Auto-Centric, Geneva Dental) were arranged over the crest of the residual ridge with their flat surfaces also contacting the underside of the template. The template was removed and the mandibular posterior castings were returned to their dies. The castings were adjusted to provide the proper amount of support and clearance required for the eventual porcelain build-up. Photocure material was added to the occlusal surfaces at the future blade area to maintain the vertical dimension of occlusion when the restorations were returned to the mouth for an esthetic try-in (Fig. 7).

The distal half of the mandibular right second molar's occlusal surface required reduction to accommodate its vertical position because the maxillary right second molar, which was not re-cast, extended below the new occlusal plane. Buff-colored wax was added and contoured to the buccal surfaces of the posterior castings.

The patient was recalled, the provisionals were removed, and the castings were seated. The mandibular trial denture was placed in the mouth and esthetics, phonetics, vertical dimension, and CR were verified with the patient standing. The provisionals were reinserted, the patient was dismissed, and the trial denture and maxillary castings were returned to the articulator.

An irreversible hydrocolloid impression of the labial surfaces and arrangement of all maxillary and mandibular anterior teeth was secured and a stone cast was produced (Fig. 8) before the wax was removed from the anterior castings with the posterior teeth in contact. This impression served as a contour guide for building the anterior porcelain restorations. Because incisal length of the maxillary central incisors was critical to this technique (Fig. 9), a condensation reaction silicone putty (Sil-Tech, Ivoclar Vivadent, Inc.) lingual matrix for the incisal length also was made.

Before building the maxillary porcel- lain restoration, it was deemed prudent to process the mandibular prosthesis and mill the occlusal plane perfectly flat. The myostatic outline on the mandibular master cast was beaded just outside the outline using a No. 2 bur. This was the extent of reduction guide for the laboratory technician when finally finishing the denture prior to insertion. The trial denture was sealed to the cast while the wax-up was prepared for investing and processing through the use of injection molding. Both occlusal reduction through milling and occlusal refinement without excessive tooth structure loss will provide the necessary interocclusal clearance when the mandible is at rest.

After processing, the denture was recovered intact on its master cast and the occlusal surfaces were milled flat on a 0.25-in. thick plate glass slab using 220 grit waterproof silicone carbide sandpaper. A black template of anodized aluminum was placed on the occlusal surfaces and viewed from the lingual toward a light source to verify the surface flatness. The processed denture was returned to its mounting on the articulator when no light could be seen through the flat surfaces placed against the template.

The set-up template was positioned atop the mandibular denture's occlusal surfaces and the maxillary castings were cleaned of all wax and photocure material. With the porcelain posterior blades and the incisal edge of the maxillary central incisors at different levels, both relative to the horizontal plane of occlusion, the anterior units were constructed first.
After the desired contour was established and with the incisal edges of the central incisors placed in contact with the set-up template, the template was removed and the posterior units were built, with the blades contacting the opposing monoplane surfaces (Fig. 10). The posterior units’ buccal slope and occlusal configuration mimicked the contour of manufactured Auto-Centric posteriors. The position of the blade in contact over the crest of the residual ridge also was critical. The mandibular malalignment on the left side required positioning the mandibular monoplane teeth lingual to the crest while increasing the buccolingual width of the maxillary molars beyond normal dimension to achieve occlusal contact (Fig. 11).

As a final esthetic check, the patient was recalled, the provisional restorations were removed, and the bisque form of maxillary units were placed in the mouth. Desired contour and long axis angulation modifications were noted on a laboratory work order. Colored pencils were used on the porcelain to indicate areas requiring change. The provisional restorations were replaced and the patient made an appointment for the delivery of the prosthesis.

The requested modifications were accomplished first with porcelain reduction where needed. To reduce the potential for excessive firing of the porcelain, buff-colored wax was added to those areas where the porcelain was deficient. When the desired changes were understood clearly, the wax was removed and the additional modifications were accomplished. Next, the anterior and posterior units were returned to the articulator and the occlusion was refined by activating the dyes with Vaseline and using full-arch articulating paper (Surgident, Heraeus Kulzer).

The markings on the blades were reduced vertically using Silky Stones (Geneva Dental) until the markings on both sides of the blades were of uniform intensity. This procedure widened the blades, which then were marked with a No. 2 pencil. Each blade was reduced on both the buccal and lingual surfaces until a thin, straight anterio-posterior line was developed. The buccal surface was shaped to provide a steeper incline, giving the blade more of a knife’s edge. The ground surfaces were smoothed using porcelain polishing wheels (Brasseler USA, Savannah, GA; 800/841-4522), the final glaze was accomplished, and the occlusion once again was checked and refined (Fig. 12).

The processed mandibular complete denture was recovered, finished, and polished. The monoplane posterior teeth were evaluated using the black template, which had been re-milled to eliminate a slight discrepancy. Two different sheets of waterproof sandpaper—a finer 320 grit, followed by 400 grit—were used to produce a smoother finish on the surfaces.

At the time of delivery, the mandibular prosthesis was fitted using water-soluble pressure indicator paste (one pound of zinc oxide powder to one pound of vegetable shortening) after the beading used to mark the myostatic peripheral extension had been eliminated. The maxillary anterior fixed restoration was seated using soft access cement and the posterior units were placed but not cemented, to facilitate removal of and extroral adjustments to the blades. The occlusion was marked as before and a minimal amount of dusting was done to balance and refine the occlusion. On subsequent visits, the patient’s mandibular monoplane teeth were examined using the black template, which was re-milled as required. The occlusion of the blades to the monoplane mandibular teeth was checked and adjusted as required using the Silky Stones.

The maxillary posterior segments were seated using soft access cement and the patient was dismissed, with instructions to return in 24 hours and as needed thereafter. After one month, the maxillary anterior restoration was cemented permanently, the flatness of the mandibular posterior teeth was confirmed, the maxillary posterior restorations were seated once again using soft access cement, and the patient was scheduled to return in two weeks for a final occlusal check and permanent cementation (Fig. 13).
Summary
The patient has been extremely pleased with both the overall appearance of the restorations and the comfort and stability of the mandibular complete denture, which has not impaired her ability to eat or speak.

A potential problem could arise from the degree of wear of the two different porcelains used but probably no more so than with any other dissimilar materials. Remaking the mandibular denture would be difficult since the blades of the maxillary posterior restorations lie below the horizontal occlusal plane but occlusal refinement and relining of the existing prosthesis could suffice for many years. When remade, the 0.020-in. anterior clearance could be re-established by arranging the mandibular monoplane teeth; first contacting the maxillary blades, then placing the set-up template on the flat posterior occlusal surfaces and arranging the anterior incisal edges until they contact the template.

To achieve the desired results, the dentist must adhere strictly to certain criteria: the mandibular myostatic peripheral extension; the horizontal plane of linear occlusion; noninterceptive, linear occlusion in posterior teeth; and the incorporation of a bilateral fulcrum of prosthetic stability in the premolar area.

Fortunately, the situation described in this article is not common but can be quite difficult and frustrating to treat when it does occur. Using the alternative tooth form and concept of linear occlusion with the myostatic outline is a logical way to achieve stability and function. Lack of anterior contact in the incisive position can be explained during consultation by emphasizing the need to preserve the remaining mandibular bony support by eliminating this source of rotation and irritation.

Disclaimer
The author has no commercial interest in any of the manufacturers listed in this article.

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References

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