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THE DENTAL
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Complete denture occlusion

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In 1972, an international workshop was held at the University of Michigan School of Dentistry that devoted 4 days to the subject of complete denture occlusion [1]. The 96 participants in attendance were divided into seven sections, and each section addressed a specific subject area within the context of complete denture occlusion. Each section was provided an extensive overview of the literature specific for the subject area as it pertained to complete denture occlusion. The subject areas were as follows:

Section I: Alveolar bone
Section II: The physiology of jaw movements
Section III: Articulators and articulation
Section IV: Occlusal patterns and tooth arrangements
Section V: Dental materials
Section VI: Postinsertion changes
Section VII: Human factors

The participants were asked to determine from their literature overview (1) what was known to be fact, (2) where fact was missing, what could be considered as belief, and (3) in the absence of fact or belief, what might be a working hypothesis to point the way for future research.

Perhaps the single most important finding from the workshop was the report prepared by the section on occlusal patterns and tooth arrangements. In their report, the section participants concluded, ''At the present, the choice of a posterior tooth form or arrangement for complete denture occlusion is an empirical procedure. Little or no supporting research is available to the profession relative to the overall effect on esthetics, function, and the long-term maintenance of the supporting tissues. All of the occlusal forms may be arranged with or without bilateral balance. A great many claims and counterclaims appear in the literature extolling the merits of a given concept or pointing out the deficiencies of another. Scores of clinically competent and

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intellectually honest professionals document clinical experiences in a very subjective manner. Since their experiences differ and their conclusions conflict, the practitioner is left to make his or her own choice. The available research fails to identify a superior tooth form or arrangement, therefore it appears logical to use the least complicated approach that fulfills the requirement of the patient'' [1].

In the past 70 years, the clinician's choice has involved occlusal rehabilitations that fall into four occlusal concepts: (1) balanced articulation, (2) nonbalanced articulation, (3) linear or monoplane articulation, and (4) lingualized articulation. Various tooth molds were selected by the clinician and arranged in a particular occlusal scheme to achieve one of these concepts. The teeth molds or forms selected for developing a particular scheme and ultimately a concept were (1) anatomic, (2) semi-anatomic, (3) non-anatomic, and (4) 0° teeth. All four types of denture teeth have been described in the literature on the basis of cusp angle, and their arrangements have been described on the basis of tooth contact relationships during articulation [2]. In 1972, Beck [3] summarized the use of these tooth forms into 10 contemporary occlusal schemes with five that demonstrated a balanced articulation concept and five that demonstrated a nonbalanced articulation.

The classic example of a balanced articulation was reported by Gysi [4,5] when he introduced the 33° cusp form arranged in accordance with the movements of the articulator. With respect to anatomic teeth, the 33° cusp form was followed by a 30° posterior tooth designed and formulated by Pilkington and Turner [6]. The 30° posterior teeth were mathematically designed and were the teeth of choice of most clinicians when developing a balanced articulation. Figs. 1 through 4 illustrate the arrangement of this

Fig. 1. The anatomic teeth are arranged in maximum intercuspation and according to a balanced articulation concept (Pilkington-Turner vacuum fired 30 degree posteriors, Dentsply International Inc., York, Pennsylvania). (Courtesy of Dr. Arthur Rahn, Medical College of Georgia, School of Dentistry, Augusta, GA.)

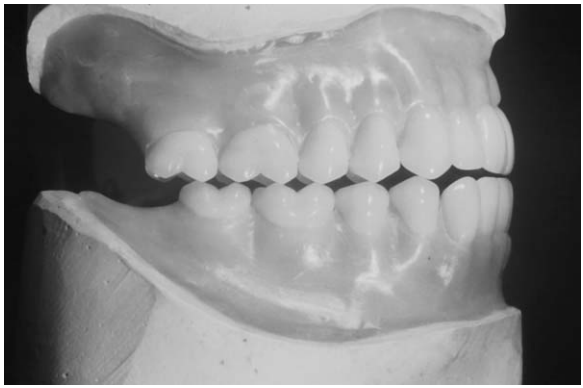

Fig. 2. The anatomic teeth are arranged with buccal cusp contacts during a protrusive movement and according to a balanced articulation concept (Trubyte Pilkington-Turner® vacuum fired 30 degree posteriors, Dentsply International Inc., York, Pennsylvania). (Courtesy of Dr. Arthur Rahn, Medical College of Georgia, School of Dentistry, Augusta, GA.)

anatomic tooth form demonstrating tooth contacts in maximum intercuspation and eccentric movement.

Non-anatomic posterior tooth forms have been developed since Gysi introduced the anatomic engineered tooth form. Many clinicians in developing a nonbalanced articulation have used these teeth. Sears [7,8] was one of the greatest exponents of non-anatomic tooth forms arranged to a nonbalanced articulation. Initially acceptance of these early tooth forms by the profession was limited. Modified non-anatomic tooth forms that have been introduced since the developed of these early types are more extensively used today. Pound [9] advocated a nonbalanced articulation that stresses the

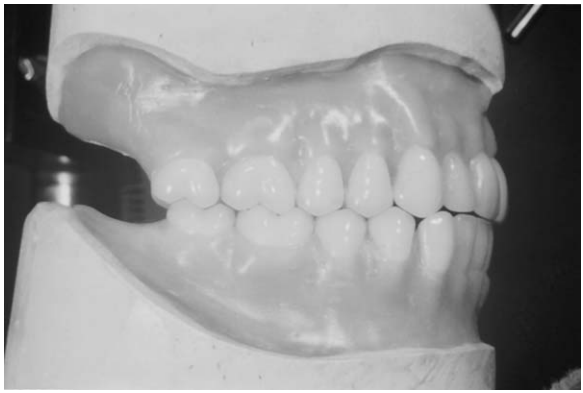

Fig. 3. The anatomic teeth are arranged to demonstrate a right working movement according to a balanced articulation concept (Trubyte Pilkington-Turner® vacuum fired 30 degree posteriors, Dentsply International Inc., York, Pennsylvania). (Courtesy of Dr. Arthur Rahn, Medical College of Georgia, School of Dentistry, Augusta, GA.)

Fig. 4. The anatomic teeth are arranged to demonstrate a left balancing movement according to a balanced articulation concept (Trubyte Pilkington-Turner® vacuum fired 30 degree posteriors, Dentsply International Inc., York, Pennsylvania). (Courtesy of Dr. Arthur Rahn, Medical College of Georgia, School of Dentistry, Augusta, GA.)

position of the anterior teeth and was developed to preserve the phonetic values of the patient in harmony with increased denture stability and efficiency in the chewing cycle. In the tooth arrangement, a sharp upper lingual cusp opposes a widened fossa in the lower teeth in maximum intercuspation. The buccal cusps of the lower posterior teeth were reduced, eliminating any deflective contacts during articulation. In effect, the occlusion is lingualized by the elimination of contacts on the buccal cusps and by the anteroposterior arrangements of the lower posterior teeth so that their lingual surfaces are on or within the lingual side of a triangle from the mesial area of the lower cuspid to the sides of the retromolar pad.

Jones [10] advocated monoplane articulation in 1972. In this concept, a non-anatomic occlusal scheme is used with a few specific modifications. The first departure is the articulator used. It should accommodate large casts, it should not show lost motion, and it should possess an incisal guide pin. Another departure is the arrangement of maxillary and mandibular teeth without any vertical overlap. The amount of horizontal overlap is determined by the jaw relationships. The maxillary posterior teeth are set first, and the occlusal plane must fulfill certain requirements. First, the occlusal plane should evenly divide the space between the upper and lower ridges. Second, the occlusal plane should parallel the mean denture base foundation. Finally, the plane should fall at the junction of the upper and middle thirds of the retromolar pads. In the final arrangement of the teeth the maxillary and mandibular teeth, except for the second molars, are in contact from anterior to posterior in maximum intercuspation. The occlusal surface of the upper second molar should be set parallel to the occlusal surface of the lower second molar but 2 mm above the occlusal plane, thus well out of occlusion. This condition is established because the first and second premolars and the first

molars masticate the food. The second molars are space fillers and do not function.

With the introduction of 0° teeth, the monoplane scheme has been used extensively in developing the occlusion for patients requiring a complete denture. The posterior teeth are positioned on a flat plane. The anterior teeth are positioned with a horizontal and vertical overlap, and the emphasis in tooth arrangement is to establish maximal tooth contact in the centric jaw relation position. Simultaneous tooth contacts in lateral and protrusive excursion are not a point of emphasis. Developing a curved occlusal plane anteroposteriorly and mediolaterally during tooth arrangement can also result in a balanced articulation when using 0° teeth. Figs 5 and 6 illustrate a balanced articulation using 0° teeth with compensating curves.

In 1927, Gysi [11] of Switzerland introduced the concept of lingualized articulation, and this initial article was followed by a number of articles presenting several modifications of the original concept. In 1941, Payne [12] reported on Farmer's posterior setup that used 30° cusp teeth that were selectively reshaped to fulfill the concept of lingualized articulation and meet

Fig. 5. 0° Non-anatomic teeth arranged to a nonbalanced articulation concept (Trubyte Rational® mold, Dentsply International Inc., York, Pennsylvania).

Fig. 6. 0° Non-anatomic teeth arranged with anteroposterior and mediolateral compensating curves demonstrating a balanced articulation concept. (Rational mold, Dentsply International Inc., York, Pennsylvania).

the individual requirements of edentulous patients. The lingualized articulation achieved through the arrangement of these modified artificial teeth was believed to allow adaptation to different types of ridges, greater masticating efficiency, elimination of lateral interferences, and settling without unbalancing the articulation by cuspal interferences. Murrell [13] described lingualized articulation as an approach to achieving success for patients with difficult lower ridges and reported that patients experienced greater chewing efficiency with this occlusal scheme. Clough et al [14] examined chewing efficiency of monoplane articulation versus lingualized articulation provided for patients involved in a clinical trial. The results of this study demonstrated that 67% of the patients preferred the lingualized articulation. The reason most given by patients in the survey instrument used for data collection was improved chewing abilities with lingualized articulation as compared with a cuspless monoplane articulation.

Other reports have described modifications to the lingual cusp form of maxillary posterior teeth and the use of these alterations within the context of lingualized articulation [2]. Among the reports are the works of Sosin [15] and Levin [16] who formed the lingual cusps of the maxillary premolars and first and second molars in a dental alloy to promote increased chewing efficiency. The introduction of special tooth forms and proposed modifications to a variety of existing tooth molds has led to confusion as to the least complicated approach to achieve a lingualized articulation. Ortman [2] has suggested, for clarity and a better understanding of the lingualized concept, that the term ''lingual cusp contact occlusion'' might be a better way to describe the contact of the maxillary lingual cusp with the mandibular teeth.

In the 70 years since the introduction of these different occlusal concepts, support for their use has relied mainly on clinical experience with little or no scientific documentation to support their efficacy. As a result, the clinician

lacks clear direction in the occlusal rehabilitation that is required and appropriate for the totally edentulous patient. The prevailing evidence that has been published that reflects clinical experience seems to support the occlusal concept of lingualized articulation [17,18].

A number of different occlusal schemes have been reported using various tooth forms to develop the lingualized articulation. Most of these schemes have involved a combination of specific tooth molds for the maxillary and mandibular arches that were not necessarily developed for this articulation (Figs. 7, 8). More recently, tooth manufacturers have specifically developed tooth molds for lingualized articulation (Figs. 9–11). It has been suggested that these mold combinations or specific molds developed according to the dictates of lingualized articulation will improve the likelihood of maximum intercuspation, with an absence of deflective occlusal contacts, an acceptable cusp height for selective occlusal reshaping to achieve occlusal contact in lateral and protrusive movements, and a natural and pleasing appearance. Arranging specific tooth molds in the articulation and arranging the denture

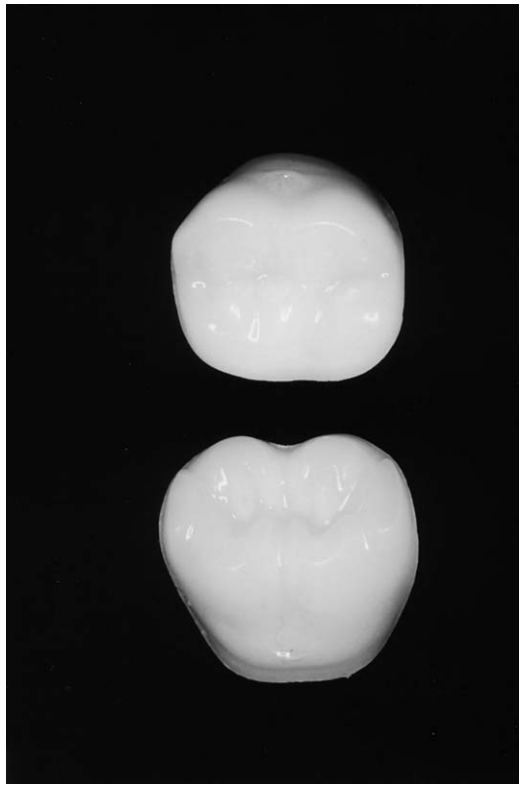

Fig. 7. Combinations of tooth forms that have been successfully used to establish the lingualized articulation concept include the maxillary Trubyte Functional® mold and the mandibular 0° or Rational mold (Dentsply International Inc., York, Pennsylvania).

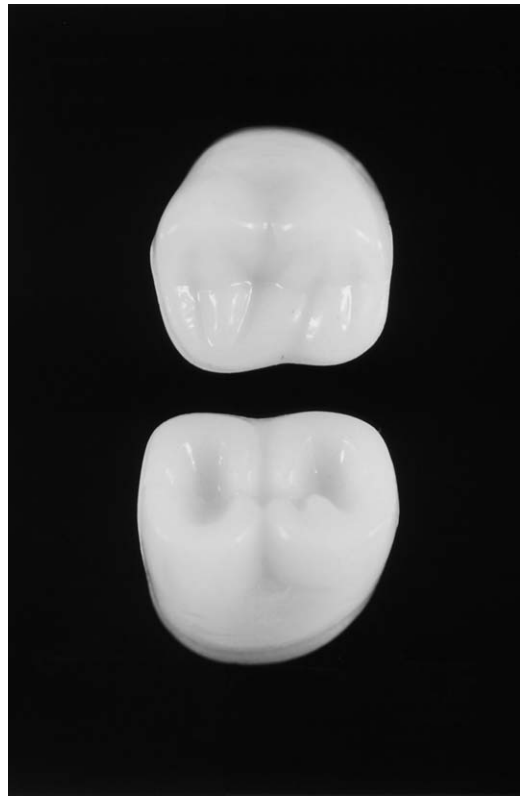

Fig. 8. Combinations of tooth forms that have been successfully used to establish the lingualized articulation concept include the maxillary Trubyte Anatoline® mold and the mandibular Monoline® mold (Dentsply International Inc., York, Pennsylvania).

teeth to meet these fundamental goals is the least complicated approach to complete denture occlusion. Ultimately, lingual articulation gives the patient improved comfort, function, and appearance, quality-of-life goals sought by the clinician and the patient alike.

Although the 1972 workshop section on occlusal patterns and tooth arrangements failed to identify a superior tooth form or arrangement for treating the totally edentulous patient, the literature and experiences of numerous clinicians have laid the foundation for what might be considered the least complicated approach that fulfills the patient's requirements, namely, lingualized articulation. Little progress has been made in fostering this concept over the past 30 years. To some extent this lack of interest can be attributed to the speculation by dental educators that the need for complete dentures would decline dramatically and that education in complete denture therapy should be removed from the dental curriculum. Douglass et al [19] have reported that this speculation was based on data from a national epidemiologic survey that projected a 10% decline in

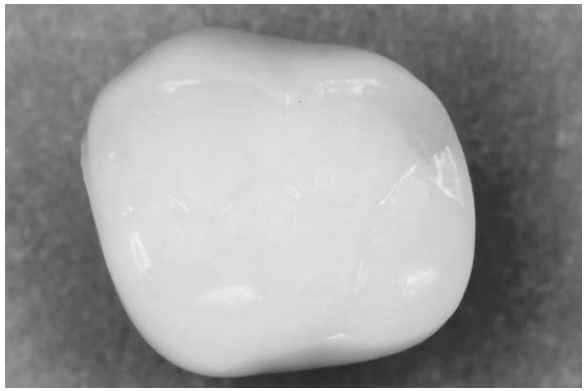

Fig. 9. The MLI tooth molds were designed for lingualized articulation. The maxillary tooth is anatomic in form with excellent cusp heights for maximum lingual cusp contact with the mandibular antagonist.

edentulism in every decade and reported that only 90% of edentulous adults obtain and wear complete dentures [19]. When the number of adults in each specific age group is multiplied by the percentage that need a complete maxillary or mandibular denture, however, the results suggest that the adult population in need of one or two complete dentures will increase from 33.6 million adults in 1991 to 37.9 million adults in 2020. The 10% decline in edentulism experienced each decade for the past 30 years will be more than offset by the 79% increase in the adult population older than 55 years of age. The clinical as well as the educational implications of these findings are significant. First, practicing dentists will find that a sizeable minority of the patient population will continue to need complete denture services. Second, if dental education in complete denture prostheses is missing from the dental

Fig. 10. The cusp heights of the MLI mandibular tooth mold are low and allow good maxillary lingual cusp contact and freedom in eccentric movements.

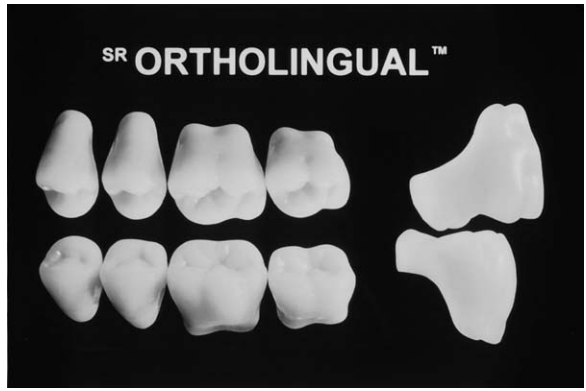

Fig. 11. The Ortholingual maxillary and mandibular tooth molds (Ivoclar Vivadent, Amherst, New York) were created specifically for the lingualized articulation concept. (Courtesy of Dr. Frank Lauicello, Ivoclar Vivadent, Amherst, NY.)

student's curriculum, millions of patients will be forced to seek denture services from alternative providers. The overall need for complete dentures will increase from 53.8 million in 1991 to 61.0 million dentures in 2020.

The need for an occlusal scheme that is the least complicated approach and that fulfills the patient's requirements is needed today even more than in 1972. Lingualized articulation seems to be that approach.

Rationale for lingualized integration

Four factors are universal to all edentulous patients during occlusal rehabilitation.

Maximum intercuspation must occur at the centric jaw relation position

The centric jaw relation position is the position at which maximum intercuspation is established. Compromised muscle control of the lower jaw, however, is common in patients who have been completely edentulous for a long time. Determining, recording, and transferring to the articulator a position that represents a reliable and reproducible centric jaw relation is essential in developing an acceptable occlusion and can be difficult in many patients. Artificial teeth with cusp forms that lock against their antagonists during articulation are unacceptable for the patient with compromised muscle control.

An absence of deflective occlusal contacts or tooth interferences must be observed between opposing teeth

Edentulous patients rarely present with the classic class I jaw relationship that is anticipated in the design of most artificial teeth. Patients may hold their mandibles in several different anteroposterior jaw positions during rest,

chewing, and swallowing. The range of this forward movement may be as great as the width of a premolar. Patients must be able to move to and from these different positions without occlusal interferences. Deflective occlusal contacts may lead to trauma, discomfort, and a lack of efficiency.

The arrangement and articulation of artificial tooth forms must provide enough cusp height to permit selective occlusal reshaping to achieve an absence of interferences

Avoiding deflective occlusal contacts requires a tooth form with some cusp height to permit occlusal reshaping and the development of a free gliding occlusion during articulation for equal load distribution and chewing efficiency.

A natural and pleasing appearance must be achievable with the tooth arrangement

The anatomic form of the facial cusps of both the maxillary and mandibular teeth as viewed along the buccal corridor enhances a patient's smile. A tooth form with a natural appearance offers the greatest potential for a pleasing, natural appearance.

The first and second factors describe specific tooth contacts that are required during the arrangement of teeth. The third and fourth factors are concerned with the design of the posterior teeth that are needed to satisfy the first and second factors. Tooth form and arrangement are inseparable and are greatly influenced the development of a lingualized articulation.

The molds for lingualized articulation

Lingualized articulation is based on the maxillary lingual cusp functioning as the main supporting cusp in harmony with the occlusal surfaces of the lower teeth. The maxillary teeth are usually more anatomic in appearance with greater cusp height (Fig. 12). The occlusal morphology of the mandibular teeth is usually uncomplicated and provides the opportunity for interdigitation of the lingual cusps of the maxillary teeth (Fig. 13). Depending on the mold selected, some tooth forms may require some minor reshaping and refinement. Such adjustments are more common in the mandibular teeth (Fig. 14). The mandibular tooth mold may require some opening of the occlusal fossa and reduction of the marginal ridges as the teeth are being interdigitated during the arrangement to achieve good contacts in maximum intercuspation. From the position of maximum intercuspation, the maxillary lingual cusps glide over the occlusal surfaces and marginal ridges of the opposing mandibular teeth without deflection during nonrestrictive lateral and protrusive movements. The cusp height of the maxillary teeth is the major difference in most tooth forms advocated for this lingualized articulation. This cusp provides the support for the vertical dimension of

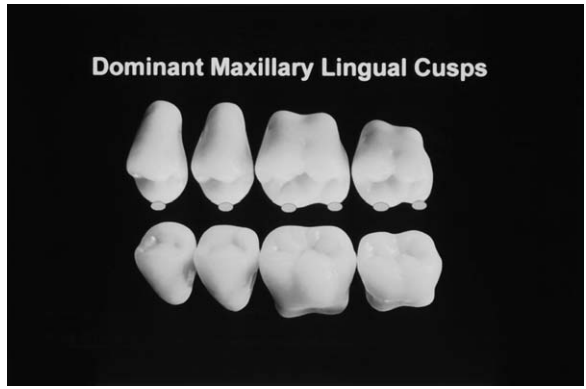

Fig. 12. Lingualized articulation is based on the maxillary lingual cusp functioning as the main supporting cusp in harmony with the occlusal surfaces of the lower teeth. The maxillary teeth are usually more anatomic in appearance with greater cusp height. (Courtesy of Dr. Frank Lauicello, Ivoclar Vivadent, Amherst, NY).

occlusion and must move over the surface of the opposing tooth in a nonrestrictive manner. The mandibular antagonists for most molds suggested for this lingualized articulation have lower cusp heights and multiple occlusal spillways to assist in mastication.

The teeth selected must provide a natural appearance to the buccal corridor. The facial surface and cusp for the maxillary tooth forms must provide the illusion of naturalness.

Factors in the tooth molds for lingualized articulation

The mandibular arch offers the most recognizable anatomic landmarks used for arranging artificial teeth. Lingualized articulation calls for an

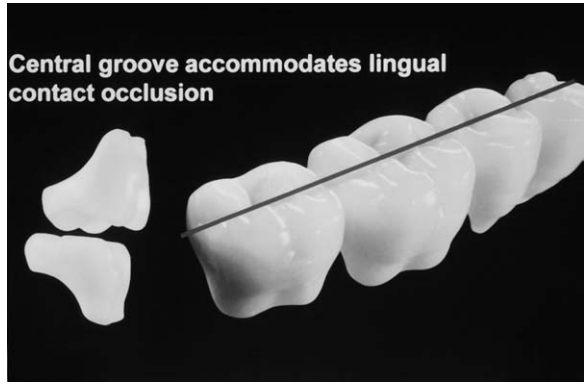

Fig. 13. The occlusal morphology of the mandibular teeth is usually uncomplicated but provides the opportunity for interdigitation with the lingual cusps of the maxillary teeth. (Courtesy of Dr. Frank Lauicello, Ivoclar Vivadent, Amherst, NY).

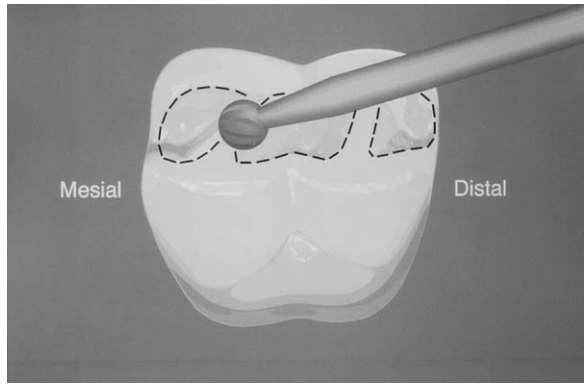

Fig. 14. Some tooth forms may require some minor reshaping and refinement. Such adjustments are more common in the mandibular teeth.

occlusal scheme in which anteroposterior and mediolateral compensating curves can be arranged in the mandibular arch, permitting balanced articulation between maxillary lingual cusps and mandibular teeth during jaw movements. The superoinferior position of the mandibular teeth in relation to the tongue and the medial roll of the buccinator muscle is an important interaction during mastication. Too high or low a plane of occlusion may destroy the smooth coordination of these structures. Of equal importance is the mediolateral positioning of the mandibular teeth to the tongue–cheek interaction and the remaining bone and soft tissue that will support the denture base. Teeth positioned too far to the lingual or facial aspects of the residual ridge are apt to compromise the stability of the denture base. For lingualized articulation the mandibular arch should be arranged first, with particular attention being given to the height of the plane of occlusion, the buccolingual positioning of the teeth, and the mediolateral and anteroposterior compensating curves.

The number of teeth selected

The number of teeth used depends on the space available for posterior teeth from the distal of the canine to the inclined plane that extends from the mean residual ridge to the retromolar pad. Positioning a molar tooth on this inclined plane usually leads to cheek biting and a forward thrust of the denture base as the maxillary teeth meet the mandibular antagonists.

Most often the available space will accommodate three teeth (Figs. 15 and 16). It is more convenient to drop the first premolar and place the second premolar and the first and second molars into the available space. Eliminating the first premolar is a logical choice, because in most molds this tooth has less occlusal surface for the mastication of food than the second premolar tooth.

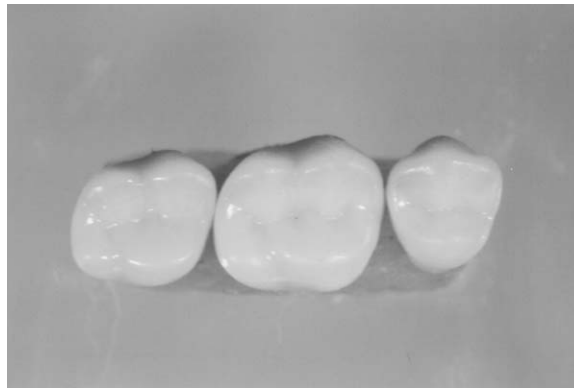

Fig. 15. When three teeth are used in the maxillary arch, the second premolar usually is the tooth that is dropped. The first premolar, because of its cusp tip–to–cervical margin length, provides a more esthetic tooth following the canine in the dental arch.

Anterior and posterior reference points

The corners of the mouth and the phonetic and esthetic arrangement of the mandibular anterior teeth establish the anterior references that assist in tooth positioning. The posterior references are points 1 to 2 mm below the height of the retromolar pads. A plane drawn through these anterior and posterior reference points establishes the plane of occlusion and serves as the starting point for the anteroposterior compensating curve (Fig. 17).

Buccolingual positioning of the teeth

The central fossae of the mandibular posterior teeth are positioned on a line that extends from the distal of the canine to the middle of the

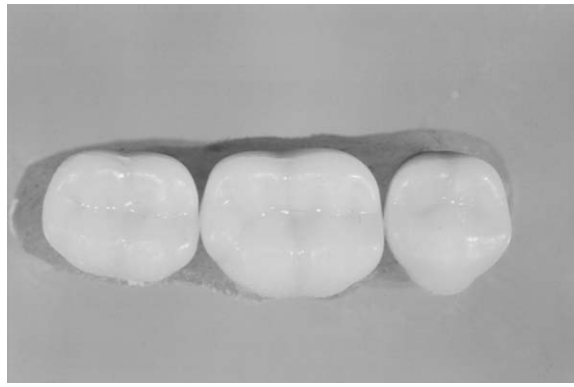

Fig. 16. In the mandibular arch, the second premolar tooth usually is dropped when arranging only three posterior teeth.

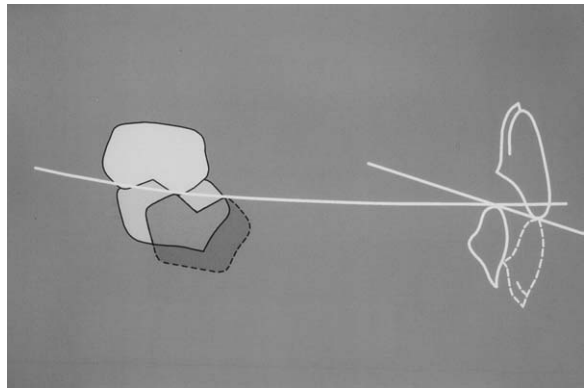

Fig. 17. A line drawn from the tips of the mandibular anterior teeth and connecting with a point 1 to 2 mm below the top of the retromolar pad establishes the plane of occlusion and serves as the starting point for the anteroposterior compensating curve.

retromolar pad. If a premolar is eliminated during the arrangement of teeth, then the first molar assumes a more anterior position. The wider first molar in the anterior position may crowd the tongue. In this situation, the two molars should be positioned slightly facial of the reference line to increase the space available to the tongue (Fig. 18).

Anteroposterior compensating curve

The anteroposterior compensating curve begins with the distal marginal ridge of the first replacement tooth in the mandibular arch and continues through the last replacement tooth. The amount of curvature depends on

Fig. 18. The width of the first and second mandibular molars necessitates positioning the central groove of these teeth slightly to the buccal of a line connecting the tip of the canines with a point in the middle of the retromolar pads. This positioning allows space for the tongue and avoids crowding this important anatomic structure during speech and mastication.

the amount of incisal and condylar guidance. More than 30° of elevation from the initial occlusal plane is rarely required. The anteroposterior curve is established to enhance balanced articulation along the protrusive pathway (Fig. 19).

Mediolateral compensating curve

A mediolateral compensating curve is established to provide balanced articulation during lateral movements. The curve is initiated with the first replacement tooth in the mandibular arch continuing through the second molar and is created by tilting the facial cusp above the lingual cusp. A mediolateral compensating curve usually will not exceed 5° to 10° from the horizontal plane of occlusion (Fig. 20).

Arranging the mandibular posterior teeth

The premolar

When only three mandibular posterior teeth are used in the occlusal scheme, the first premolar is the tooth usually selected for arrangement. It is essential that this tooth be arranged with the long axis perpendicular to the occlusal plane. The premolar should be set with its occlusal fossa centered on the buccolingual reference line. The facial cusp should be tilted slightly above the lingual cusp to dictate the start of a mediolateral compensating curve of approximately 5° to 10°. If four teeth are to be used, both premolars are centered on the reference line perpendicular to the plane. In this situation, the compensating curve still begins with the second premolar.

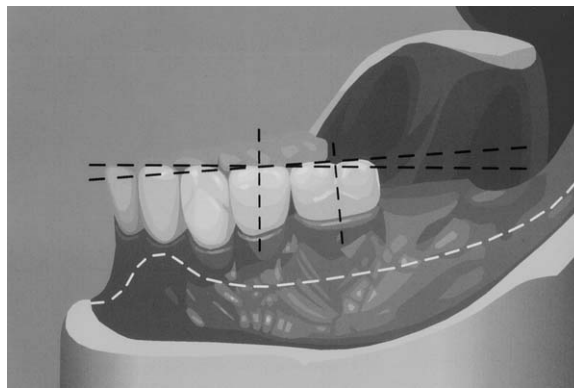

Fig. 19. The anteroposterior compensating curve is established to enhance balanced articulation along the protrusive pathway. The curve begins with the first premolar, and the first and second molars are slightly elevated above the plane of occlusion.

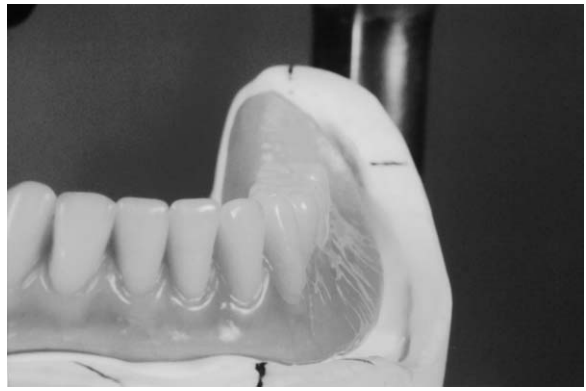

Fig. 20. The mediolateral compensating curve is a subtle curve that usually does not exceed 5° to 10° above the horizontal plane of occlusion.

The first molar

The first molar is placed with the mesial marginal ridge level with the distal of the premolar. The distal of the molar is elevated approximately 1.0 mm above the occlusal plane, thereby initiating the anteroposterior compensating curve. The central fossa of the first molar is positioned slightly to the facial of the buccolingual reference line to avoid the possibility of crowding the tongue. The facial cusps are tilted slightly above the lingual cusps continuing the mediolateral compensating curve.

The second molar

The mesial marginal ridge of the second molar is positioned level with the distal of the first molar. The distal of the molar is slightly elevated, continuing the anteroposterior compensating curve. In general, the distal of the second molar is at the height of the top of the retromolar pad. The central fossa of the second molar is positioned to the facial of the buccolingual reference line and in a straight line with the first molar. The buccal cusps are elevated to continue the mediolateral compensating curve.

Arranging the maxillary posterior teeth

The mandibular teeth influence the arrangement of the maxillary teeth (Fig. 21). The lingual cusps of the maxillary teeth remain the main supporting cusp for this occlusal scheme and for lingualized articulation. Throughout the arrangement, it is important to strive for maximum interdigitation without any modification to the lower occlusal surfaces or marginal ridges during the arranging of the teeth (Fig. 22). With certain tooth molds selected for lingualized articulation, however, some occlusal modification may be necessary. When modification is necessary, the primary

Fig. 21. Proper arrangement of the mandibular teeth is completed before arranging the maxillary posterior teeth. In this way, the plane of occlusion and the compensating curves are established and will influence the arrangement of the maxillary teeth.

consideration is maintaining the maxillary cusp, with the sacrifice of the lower mold. Thin articulating paper is interposed between the maxillary tooth and its antagonist and marked by articulator closure. The lower teeth are reshaped to maximize the contact between the maxillary lingual cusp and the mandibular antagonist. Regardless of the mold selected, no attempt is made to establish a class I molar relationship.

The premolar

Because three teeth may have been set in the mandibular arch, only one premolar tooth can be used in the maxillary arch. The first premolar is the tooth usually selected for arrangement. The length of this tooth from cusp

Fig. 22. It is important to achieve maximum interdigitation of the maxillary teeth in the central groove of the mandibular antagonists in the arrangement of the lingualized articulation scheme to establish the maxillary lingual cusps as the main supporting cusp.

tip to cervical margin is usually greater than the second premolar, providing a more esthetic appearance when positioned beside the canine tooth. This tooth must be arranged with the long axis perpendicular to the mandibular occlusal plane. This positioning enhances the appearance along the buccal corridor and allows better interdigitation of the premolar lingual cusp with the mandibular occlusal plane. Contact of the maxillary tooth with the mandibular antagonist may occur on a marginal ridge or in the central fossa of the mandibular premolar. The interdigitation depends to some extent on the skeletal positioning of the mandible to the maxillae. The buccal cusp of the premolar should be arranged with approximately 1 to 2 mms of horizontal overlap between the maxillary and the mandibular facial cusps. When four teeth are used, the same criteria are used for arranging both premolars.

The first molar

The first molar is positioned with the marginal ridge in contact with the premolar and the facial surfaces aligned. The lingual cusps should contact the central fossa or marginal ridges of the mandibular antagonist. The horizontal 1 to 2 mms of overlap should be continued.

The second molar

The mesial marginal ridge of the second molar should be aligned with the distal marginal ridge of the first molar. The lingual cusps should be in contact with the central fossa or marginal ridges of the mandibular antagonist. The horizontal 1 to 2 mms of overlap should be continued.

Evaluating lingualized articulation with the trial denture

Fundamental to lingualized articulation is maximal intercuspation between the maxillary lingual cusps and the mandibular antagonists at the centric jaw relation position. There must be no deflection between the maxillary and mandibular teeth. When this alignment is achieved, there is, in effect, a balanced articulation. In equalizing the tooth contacts during lateral excursions, the lingual inclines of the maxillary facial cusps and the facial inclines of the mandibular cusps must be free of interferences on the working side. Balancing contacts during this working movement occur on the opposite side of the mouth, between the maxillary lingual cusp and the lingual incline of the mandibular facial cusp. Often these contacts may not be completely visible in the mouth with the trial implant prosthesis, as they are on the articulator. A lack of balanced articulation can be expected at this time. Occlusal refinement should be deferred until the teeth are fixed in the prostheses by acrylic resin. The potential to develop these tooth contacts must be present with the trial prosthesis, however, to ensure that enough tooth material is available for occlusal reshaping to a balanced articulation

after processing. If it seems that a balanced articulation cannot be achieved following processing, then the anteroposterior and mediolateral compensating curves should be reevaluated, and it may be necessary to increase the steepness of either or both of these curves.

Refining lingualized articulation after processing

Processing changes coupled with a lack of complete balanced articulation before the processing of the prosthesis necessitates selective occlusal reshaping during remount procedures to achieve lingualized articulation completely. The occlusal reshaping techniques are usually performed at the prosthesis insertion appointment.

Establishing maximum intercuspation

It is much easier to develop maximum intercuspation at the centric jaw relation position when the prostheses are on the articulator. Once maximum intercuspation is achieved, balanced articulation in the several eccentric movements may be attained in the mouth.

After the clinical remount of the maxillary and mandibular prostheses, small strips of articulating paper should be interposed on both sides of the mandibular arch. With the articulator locked in the hinged position, all occlusal prematurities should be marked. Tooth structure should be removed in all areas of contact using carbide trimming and finishing bur #7010 (Brasseler, USA, Savannah, Georgia), except the maxillary lingual cusp. Premature contacts are most often at the central fossa or marginal ridges of the lower teeth and on the lingual incline of the maxillary facial cusp. The contacts should be marked and the teeth reshaped until all lingual cusps in the maxillary posterior teeth demonstrate maximal intercuspation with their mandibular antagonists. This procedure establishes the maxillary lingual cusp as the main supporting cusp in the occlusal contact pattern, but it is usually accomplished with a minimum of adjustment (Fig. 23). The prostheses are returned to the mouth after the occlusal reshaping procedures to verify that maximal intercuspation has been achieved at the centric jaw relation position (Fig. 24).

Adjusting the working and balancing contacts

Concurrent working and balancing occlusal contacts requires the judicious reduction of deflective working-side interferences that were created with the increase of maxillary facial cusp overlap during the adjustment of maximal intercuspation.

Adjusting the working and balancing contacts are clinical procedures to be completed after the maxillary and mandibular dentures are positioned over the residual ridge. With articulating paper positioned between the posterior teeth bilaterally, the patient should be carefully guided into a lateral

Fig. 23. Solid contact between the maxillary lingual cusps and the mandibular central groove is accomplished with a minimum of adjustment.

movement. The extent of the movement will be approximately 2 to 3 mms in the molar region. Working interferences will appear as markings on the lingual inclines of the facial cusps of the maxillary teeth as they pass over the facial incline of the mandibular facial cusps. Occlusal reshaping procedures using the carbide trimming and finishing bur #7010 are completed by gently grinding the lingual inclines of the maxillary facial cusp that demonstrate interferences. Premature cross-arch balancing contacts on the lingual inclines of the mandibular facial cusps must be reduced to provide freedom of movement on the contralateral working cusps (Figs. 25 and 26).

Balancing interferences and maximal intercuspation contacts may occur near to each other on the occlusal surfaces of the mandibular teeth. The maximum intercuspation stop is generally in the central portion of the tooth; balancing contacts begin in this area and move in a distal facial direction onto

Fig. 24. Maximum intercuspation is verified in the oral environment following the occlusal reshaping procedures.

Fig. 25. Smooth, free-gliding articulation must be observed in lateral excursions. The working movement should demonstrate light contact between the maxillary buccal cusps with the mandibular buccal cusps in the lingualized articulation concept.

the lingual incline of the mandibular facial cusps. The balancing contact markings may be narrow, and care must be used in reducing balancing interferences. If the balancing contact must be reduced, only the facial portion of the mandibular marking is altered. Selective grinding of the entire contact area results in the loss of maximal intercuspation. The selective occlusal reshaping procedures should be continued until a smooth, free-gliding movement is observed.

Adjusting the protrusive contacts

Articulating paper should be positioned between the posterior teeth bilaterally, and the mandible should be guided into a protrusive movement from maximal intercuspation. Premature protrusive contacts may appear

Fig. 26. On the balancing side the maxillary lingual cusps should glide smoothly over the lingual inclines of the mandibular buccal cusps in the lingualized articulation concept.

Fig. 27. In a protrusive movement in lingualized articulation, the maxillary anterior teeth should demonstrate only light contact with the anterior mandibular teeth. The maxillary posterior teeth in contact with the mandibular posterior should not occlude the anterior teeth.

between the lingual inclines of the maxillary facial cusps and the facial inclines of the mandibular facial cusps during this movement. Such contacts may be eliminated by grinding on the mandibular facial cusp. Once again, care must be taken, because the maxillary facial cusp is the working cusp, and grinding this area might eliminate a working contact. When the anterior teeth are brought into contact by a protrusive movement, it is desirable that all the posterior teeth contact bilaterally (Figs. 27 and 28).

Evaluating lingualized articulation at the insertion appointment

After the occlusal reshaping procedures for maximal intercuspation, working, balancing, and protrusive movements are accomplished, the occlusion is examined for holding contacts in centric jaw relation position.

Fig. 28. In the protrusive movement, there should be only light maxillary buccal cusp contact with the mandibular posterior teeth. The maxillary lingual cusps often also establish contact with the mandibular occlusal surfaces in lingualized articulation.

The occlusion is also examined for an absence of interference during mandibular movements. With lingualized articulation using the tooth molds previously discussed, these criteria are easily met.

Summary

Lingualized articulation has been advocated by many practitioners over the past 60 years. It can be achieved using a variety of tooth molds arranged in a number of ways that seem to provide the least complicated approach to occlusal rehabilitation and to satisfy the needs of the edentulous patient. Clinical experience has supported its use during functional and nonfunctional activities [17,18]. The different combinations of tooth molds available from one particular tooth manufacturer, and now specific molds designed for lingualized articulation by other manufacturers, allows the practitioner to improve the likelihood of maximal intercuspation, avoid deflective occlusal contacts, determine cusp height for selective occlusal reshaping, and achieve a natural and pleasing appearance. The articulation and arrangement of the posterior teeth in lingualized articulation assures a standardized arrangement.

References

[1] Lang BR, Kelsey CC, editors. International prosthodontic workshop on complete denture occlusion. Ann Arbor (MI): The University of Michigan, School of Dentistry; 1973.
[2] Ortman HR. Complete denture occlusion. In: Winkler S, editor. Essentials of complete denture prosthodontics. 2nd edition. Littletown (MA): PSG Publishing Co.; 1988. p. 217–49.
[3] Beck HO. Occlusion as related to complete removable prosthodontics. J Prosthet Dent 1972;27:246–56.
[4] Gysi A. Masticating efficiency in natural and artificial teeth, III. The bites in natural and porcelain teeth. Dent Dig 1915;21:139–45.
[5] Gysi A. Practical application of research results in denture construction. J Am Dent Assoc 1929;16:199–223.
[6] The new Pilkington-Turner vacuum fired 30 degree posteriors. York (PA): Dentists' Supply Company of New York; 1953. p. 48.
[7] Sears VH. Thirty years of nonanatomic teeth. J Prosthet Dent 1953;3:596–617.
[8] Sears VH. Occlusal pivots. J Prosthet Dent 1956;6:332–8.
[9] Pound E. Utilizing speech to simplify a personalized denture service. J Prosthet Dent 1971; 24:586–600.
[10] Jones PM. The monoplane occlusion for complete dentures. J Prosthet Dent 1972;85: 94–100.
[11] Gysi A. Special teeth for cross-bite cases. Dent Dig 1927;33:167–71.
[12] Payne SH. A posterior set-up to meet individual requirements. Dent Dig 1941;47:20–2.
[13] Murrell GA. The management of difficult lower dentures. J Prosthet Dent 1974;32:243–50.
[14] Clough HE, Knodle JM, Leeper SH, Pudwell ML, Taylor DT. A comparison of lingualized occlusion and monoplane occlusion in complete dentures. J Prosthet Dent 1983;50:176–9.
[15] Sosin MB. Reevaluation of posterior tooth forms for complete dentures. J Prosthet Dent 1961;11:55–61.

[16] Levin B. A review of artificial posterior tooth forms including a preliminary report on a new posterior tooth. J Prosthet Dent 1977;38:3–15.
[17] Lang BR, Razzoog ME. A practical approach to restoring occlusion for edentulous patients. Part I: guiding principles of tooth selection. J Prosthet Dent 1983;50:455–8.
[18] Lang BR, Razzoog ME. A practical approach to restoring occlusion for edentulous patients. Part II: arranging the functional and rational mold combination. J Prosthet Dent 1983;50:599–606.
[19] Douglas CW, Shih A, Ostry L. Will there be a need for complete dentures in the United States in 2020? J Prosthet Dent 2002;87:5–8.