

Selection of articulator for general dental practice

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The success of fixed or removable restoration directly depends on the articulator selected as well as the skill and care with which it is used. Articulator is defined as a mechanical instrument that represents the temporomandibular joints and jaws, to which maxillary and mandibular casts may be attached to simulate some or all mandibular movements¹. Mandibular movements occur around the temporomandibular joint which is capable of making complex movements. Based on dimension involved in the movement, mandibular movement can be classified as (a) rotation around the transverse or hinge axis, (b) rotation around the anteroposterior or sagittal axis, (c) rotation around the vertical axis, (d) translation in time. Any restoration provided should not interfere with mandibular function in mastication, speech, and swallowing nor should they transmit excessive force to the attachment apparatus or the temporomandibular joint either in the intercuspal or eccentric jaw positions as well as during movement².

Numerous articulators are available for the restoration of occlusion. The challenge for the dentist is to choose an articulator that is suitable for the purpose at hand, neither more nor less complicated than necessary. Generally single crowns and simple fixed partial dentures are fabricated on simple articulators consisting of nothing more than a simple hinge. These nonadjustable articulators do little more than simulate the hinge motion of the mandible and hold the casts in centric relation. Occlusal inaccuracies produced by this type of instrument may be corrected intraorally using valuable chair time but the final restoration is a result that is less than optimal. Many inaccuracies, however, remain unrecognized and these remain in mouth as occlusal interferences which frequently may produce pathologic conditions ranging from destruction of teeth and supporting structures and/or TMJ disturbances^{3,4}.

Semiadjustable articulator allows adjustment to replicate average mandibular movements. These instruments allow for orientation of the cast relative to the joints and may be *arcon* or *non arcon*

instruments. These articulators are most often indicated for balanced complete dentures, for Class I and Class II partial dentures and for crowns and three unit fixed partial dentures.

Fully adjustable articulators duplicate the mandibular movements with a higher degree of precision. These instruments allow for orientation of the cast to the temporomandibular joints and replication of all mandibular movements. Inaccuracies in the restoration can be highly limited by the use of these articulators; however, treatment using these instruments is time-consuming, demand great skill by the dentist and the technician, hence, economically not feasible for smaller routine treatment plans⁴.

Review of Literature

Stuart CE⁵ described the movements of the mandible and emphasized the importance of reproducing those border and habitual movements with the articulator. The author concluded that the use of the fully adjustable articulator is an accurate method of studying mandibular movement which "becomes a fascinating game". Understanding the masticatory system is basic to progressing in our learning in the field of dentistry.

In a study conducted by Weinberg LA⁶ to evaluate the condylar articulator (non arcon) with the arcon articulator, the protrusive and lateral records were placed on both types of instruments and readings were calculated mathematically.

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In protrusive position, both instruments measured the same. The balancing condylar positions were identical on both articulators. Bennett angle readings were different on the two instruments due to the mechanical method of producing the motion. The position of the balancing condyle and motion were identical on each instrument. He concluded that both the arcon and non arcon articulators produce the same motion because condylar guidance is the result of the interaction of a condylar ball on an inclined plane. Mathematical evidence proves that neither instrument has any specific advantage over the other.

Weinberg LA⁷ discussed the principles that apply on fully adjustable articulators. He stated that fully adjustable articulators are extremely accurate in duplicating the three-dimensional motion of the condyle. Semiadjustable articulators are adequate for complete denture construction and their settings are based on clinical averages. The most serious error that is created by semiadjustable articulators is a space between the posterior teeth during lateral excursions on the working side due to negative error. Fully adjustable articulators can reduce the amount of intraoral corrections to be made and will accept all non-pathologic records.

Javid NA⁸ studied the condylar guidance angles for protrusive and lateral progressive side shift in three different kinds of articulators. Two Denar D4-A, two Whip-Mix, and two Hanau model 130-28 articulators were used. Five patients whose kinematic axes have been located were used. Protrusive and lateral interocclusal records were made of acrylic. The protrusive and lateral condylar guidances of all six articulators were adjusted with both the protrusive and lateral interocclusal records. He concluded that the condylar guidance of the Denar articulator is more stable than the Hanau or Whip-Mix used in this study.

Javid NS and Porter MR⁹ investigated the accuracy of the Hanau formula for use in the construction of complete dentures. Six articulators (two Denar D4-A, two Whip-Mix and two Hanau model 130-28) were used. Maxillary and mandibular alginate impressions were made and duplicated for five patients. The Denar hinge axis face-bow kit was used to transfer the upper cast of all patients to the articulators. The mandibular casts were articulated in maximum intercuspation. Protrusive and lateral interocclusal records were made for each patient. The horizontal and lateral condylar inclinations were adjusted on all articulators using the protrusive and lateral records. The actual recordings were compared to the values obtained by using Hanau's formula. They concluded that the range of means of lateral condylar guidances

of Hanau articulators using the Hanau formula was small. This small possibility of variation in the lateral condylar guidance would suggest the use of lateral interocclusal records when precise restorative procedures are necessary.

Hobo S et al.⁴ reported that a nonadjustable articulator with a fixed condylar path is acceptable for single restorations. A shallow 20° fixed condylar inclination is desirable because the error will usually be a negative error. Multiple restorations or FPD's can be fabricated on a semiadjustable articulator. A face-bow transfer will minimize tooth hinge axis errors. The fully adjustable articulator is indicated for extensive treatment of the occlusion, significant side shift movements, and restoring lost vertical dimension of occlusion.

Mohamed SE et al.¹⁰ in a survey found that 64% of practicing dentist used a hinge or simple articulator, 26% used a semiadjustable, and 10% used a fully adjustable articulator. The most common complaints of the lab technicians were poor registration records and poor impressions. They preferred that the dentist articulated the casts prior to referring them to the lab.

Authors thought it would be better to place emphasis on the selection of an articulator dependent upon the difficulty encountered with each patient, rather than learning to use one articulator - i.e. semiadjustable.

In a survey conducted by Smith D¹¹ to determine the type of articulators used in teaching fixed and removable prosthodontics in the 59 United States dental schools, following observations resulted from analysis of the questionnaire. Of the 81 articulators used in fixed and removable prosthodontics, 65 (76.5%) were of the arcon design. The most common articulators used were the Whip-Mix (16 schools), the Hanau 158 (14 schools), the Hanau 96 H-2 (13 schools), and the Denar Mark II (11 schools). The most common articulators used in fixed prosthodontic programs were the Whip-Mix (16) and the Denar Mark II (11), while the most common articulators for removable prosthodontics were the Hanau 158 (14) and the Hanau 96 H-2 (13). The outstanding difference in requirements for fixed and removable prosthodontic teaching programs was that those in fixed prosthodontics preferred an articulator that allows separation of the maxillary and mandibular members, while those in removable prosthodontics did not.

Hindle JR and Craddock HL¹² aimed to determine which articulators were recommended for various restorative procedures in UK dental schools, for use by undergraduate students. A questionnaire-based study of all UK dental schools was carried out, with a

100% response rate. Recommended articulator application for specified procedures was established from the literature and questionnaire results were compared with this. The results indicated that dental schools in the UK generally teach appropriate articulator use for most procedures. However, there are some limited areas of what may be argued to be inappropriate recommendation in some establishments.

Discussion

Articulators vary widely in their abilities to reproduce the biomechanical factors associated with mandibular movement. The more complex the instrument, the greater the range of adjustments and potential accuracy in reproduction of condylar translation associated with protrusive and lateral border movements; and the greater the likelihood that the articulation of the teeth in eccentric mandibular movements will duplicate those observed in the patient^{2,5}.

There is considerable controversy as to which articulator is 'best' for a particular dental procedure. Choice is made on the basis of what is expected of it. When an articulator is selected for complete denture construction, the type will somewhat depend on (a) the type of occlusion to be developed, (b) the type of posterior tooth form, (c) the type of excursive tooth guidance, (d) the type of jaw relation records that can be made to adjust the articulator. Simple sturdy hinge type of articulator without provision for lateral or protrusive movements could be selected if occlusal contacts are to be perfected in centric occlusion only. Hobo S. et al⁴ reported that a nonadjustable articulator with a fixed condylar path is acceptable for single restorations. If denture teeth are to have cross-arch and cross-tooth balanced occlusion, minimal requirement is semiadjustable articulator. Weinberg LA⁷ reported that semiadjustable articulators are adequate for complete denture construction. If complete control of occlusion is desired, a completely adjustable, three-dimensional articulator is of value. However more complicated articulators pose some problems for use in making complete dentures because of resiliency of soft tissues of basal seat on which the recording bases must rest^{13,14}.

For Class III partially edentulous patients, a simple hinge or a nonadjustable articulator is frequently indicated. For most Class I and II partial denture, a semiadjustable instrument is most often indicated. The fully adjustable articulator is usually limited to those patients needing a removable partial denture and where the entire occlusal scheme is to be

developed at one time by the wax additive technique¹⁵.

While considering fixed prosthodontic restoration, for crowns and three-unit fixed partial dentures, semiadjustable articulator is generally preferred, whereas, for full mouth reconstruction or multiple units, fully adjustable articulator is preferred⁴. Smith¹¹ reported that in the United States dental schools, the Whip-Mix and Denar were the most commonly used articulators used for fixed restorations while a Hanau model was more commonly used for removable. Mohamed et al¹⁰ found that 64% of practicing dentist used a hinge or simple articulator, 26% used a semi-adjustable, and 10% used a fully adjustable articulator. Schweitzer¹⁶ in 1981 found that he had equal amounts of success using different articulators.

Current popular articulators

1. Mean Value Articulator (Fig. 1)

Also called as "Three Point Articulator or Free Plane Articulator", these instruments are routinely used in dental colleges to teach undergraduate students. These instruments are nonadjustable, non arcon type, designed using fixed dimensions. A spring is mounted within the condylar track to stabilize the condylar elements and hold them in their posterior most position.

2. Hanau H2 Articulator (Fig. 2)

These instruments are condylar or non arcon type. Its prototype, the model H, designed by Rudolph Hanau, was originally designed for complete denture construction, both models have received widespread acceptance throughout dental profession. The Hanau H 2 articulator has a fixed Intercondylar distance of 110 mm and does accept a face-bow transfer. The lateral horizontal condylar inclinations are simulated by means of a protrusive interocclusal record. Hanau suggested the formula $L = (H/8) + 12$ (L = Lateral condylar angle in degrees and H = horizontal condylar inclination in degrees) to arrive at an acceptable side shift angle¹³. The lateral adjustment for side shift range from 0-30 degrees. The mechanical incisal guide table is adjustable both in sagittal and frontal planes.

The face-bows that can be utilized with the Hanau H2 articulator are the facia face-bow, the earpiece face-bow, the Twirl-bow and the adjustable axis or kinematic face bow. An extendable shaft permits the use of kinematic face-bow. The extendible condylar shaft feature is indicated by an "X" after the model designation, for example, H2-X. When orbitalae is used as the anterior reference point for making the face-bow transfer, orbitalae pointer of the face-bow

(facia or earpiece face-bow) is related to the orbitalae indicator on the upper member of the articulator¹⁷.

3. Whip – Mix Articulator (Fig. 3)

The basic Whip-Mix is an arcon articulator. It was designed by Charles Stuart in 1955 so that restorative dentistry could be accomplished with greater precision without the use of very expensive equipment or more time consuming techniques. The intercondylar distance is adjustable to three positions: small (S), 96mm; medium (M), 110 mm; and large (L), 124 mm; by means of removable condylar guidance spacers along the instrument's horizontal axis. The horizontal condylar inclinations are set by means of a lateral or protrusive interocclusal record. The amount of Bennett movement is set by means of a lateral interocclusal record. The articulator is available either with a mechanical incisal guide table, adjustable in both sagittal and frontal planes, or with a plastic incisal guide table that can be individually customized. The upper and lower members are mechanically attached by means of a spring latch assembly. The face bows that can be utilized with the Whip-Mix articulator are Quick Mount or earpiece face-bow and the adjustable axis or kinematic face-bow. The bridge of the nose is utilized as the anterior reference point with the earpiece face-bow. The incisal guide in is straight and one end is flat and the other end rounded¹⁷.

The basic Whip-Mix articulator has numerous modifications that are available. Condylar thumb-lock screws may be added to assure proper seating of the condyles when making hinge articulator movements. Optional immediate side shift guides are available from 0.25 mm to 1 mm. Some additions to the basic articulators are curved condylar guides with an immediate side shift adjustment and the Accumount mounting system for interchanging casts between articulators¹⁷.

Conclusion

The choice of articulator depends upon such factors as (a) intended use, (b) availability of equipment, (c) patient's occlusion, (d) skill of the technician, (e) skill of the operator, (f) expense. No existing articulator will reproduce all mandibular movements exactly, nor is this its primary objective. The goal is to make restoration with occlusal morphology compatible with the movements of mandible. The more closely the articulator matches the patient's anatomy, usually the better the outcome and the less adjustment is required at chair-side on fitting prostheses. The late Carl O. Boucher¹⁸ summed up the articulator controversy by stating, "It must be recognized that the person operating the instrument is more important than the instrument. If dentists understand articulators

and their deficiencies, they can compensate for their inherent inadequacies."

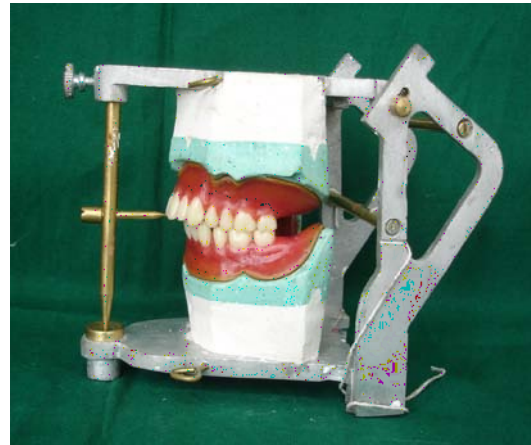


Fig 1: Mean Value Articulator



Fig 2: Hanau H2 Articulator



Fig 3: Whip-Mix Articulator.

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