Review Article

Articulators in current use: A review

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Abstract

Clinician always tries to aim for ways to simplify the procedures of fabricating a prosthesis and to reduce the time required for it to adapt into the patient's mouth.

The mouth of the patient is often considered as the best articulator. However, it is not mechanically possible to perform many procedures intraorally, which are involved in the construction of fixed or removable prosthesis. Hence, for the convenience of the patient, the dentist and the dental laboratory technician it becomes necessary to use an analogue for jaw movements, the articulator.

Regardless of simplicity or complexity of the articulator, its effectiveness relies on the operators understanding of its features, the accuracy of registering and transferring patients jaw relations and how the operator uses it.

Introduction

The temporomandibular joint has a complex mechanism; it not only permits movements like pivoting, rotating, opening and closing, but it also allows movements of translation and laterotrusion. Furthermore, the structures of the joint are not rigid, precise, and unmodifiable; rather, the muscles, ligaments and bone have a certain degree of elasticity. In accordance with this fact, the clinician has to fabricate a prosthesis that is within the adaptive capacity of this neuromuscular system. So, it is a mechanical device that represent the maxilla, mandible and TMJ. They mainly provide a framework where it is possible to relate, the maxillary cast with the mandibular cast in the three planes of space, relative to the patient's hinge axis and also of the instrument.

"Glossary Of Prosthodontics Terms" 9th edition -

"It is a mechanical device which represents the temporomandibular joint and jaw member to which maxillary and mandibular casts may be attached to simulate some or all of the mandibular movements".

ARTICULATORS IN CURRENT USE

THE GALETTI ARTICULATOR

The Galetti articulator was manufactured in 1950. In this device, plaster is not used to mount the cast but instead, two fixed posts in the front and one adjustable post at the back of the articulator holds the casts in place permitting a rapid mounting. [1]

It has fixed condylar guides and do not accept facebow transfer

HANAU ARTICULATORS

In 1921, Rudolph Hanau invented the Hanau-brand articulator. The articulator was designated as Model H and was originally designed for complete dentures.

The Hanau Model M Kinescope (1923)

Later in 1923, he invented another study model, called the "Hanau Model M Kinescope" articulator with two condylar posts on both sides. Here, Bennet angle can be adjusted. [1] [2]

The Hanau Model H Series Articulator (1923)

These models accept face Bow. Horizontal condylar guidance was adjusted by Protrusive inter occlusal record.

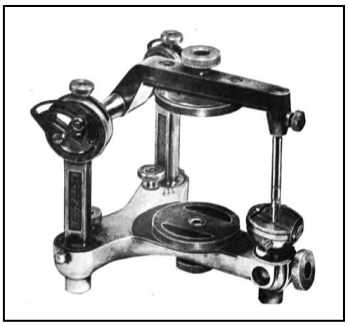


Fig. 1

In these instruments, the lateral guidance was set by using the formula L=H \ 8+12 [2]. These were arcon instruments having incisal guide table which permitted wide range of three-dimensional adjustments. (Fig. 1)

The Hanau Model H_2 Series (1958)

This series was developed in 1958. Some models are: Model H2-O (with attached orbital indicator), Model H2-PR (with calibrated adjustments to protrude or retrude the condylar balls up to 3 mm, H2-X (with extendable condylar shaft) and Model H2 – XPR (combined features of above models), Model 96H2

Model 96H2

This is the current model of the original articulator. It maintains most of the features of the model H. The condylar elements are on an axle attached to the upper frame. The guidance assembly is a closed-slotted system that is a component of the lower member and is fixed at 110 mm. [3]

The side shift (Bennett angle) is adjustable from 0° to 30° and is progressive in nature. The horizontal condylar guidance is adjustable from 0° to 75° and is rectilinear in nature.

Model 158 (1977)

The Hanau 158 model was made in 1977. Most of its features are similar to the 96H2 except that it is an arcon type instrument. A special face-bow is used with this articulator, but it can receive most other face-bows. [3] [8] The horizontal condylar path can be adjusted from 0° to 60°, and the side shift can be adjusted from 0° to 30°.

Model 165 Hanaumate

It is based on fixed average values incorporated into its design. The condylar element is at 110 mm, 30º horizontal inclination, 15° progressive side-shift, and 10º exclusive inclination on the incisal guide table. [4] [5] The upper member can be detached easily by opening the two locks. It can receive various face-bows. Cast are mounted using quick-release pins instead of mounting plates. There is excellent lingual visibility.

Model 166 Radial Shift (1981)

Arcon type, Fixed Inter Condylar Distance - 100 mm**.** Horizontal condylar guidance is adjustable from 0° - 60° and has ¾ inch curvature. [3] Medial wall has precurrent side shift curvature of 3mm radius which is adjustable from 0-3 mm.

Wide-Vue Models 183 And 184

The Hanau models 183 (Fig. 2) and 184 are arcon type instruments having similar features. [6] The difference being that the

upper and lower frames on the 184 model can be separated.

Fig. 2

The design permits great visibility from the posterior aspect amongst any of the Hanau models. The horizontal condylar path angle can be adjusted from -20° to 60°, and the side-shift angle can be adjusted from 0° to 30°. Both have rectilinear guidances. [7]

Modular Articulator System

This is a system with a series of interchangeable guidance assemblies. The basic frames of the articulator are produced in two forms, one with a fixed intercondylar width at 110 mm and an adjustable version with adjustable intercondylar width at 100, 110 125, and 140 mm. The choices include the following:

Adjustable "Bennett" (side shift) - The side shift is adjustable from 0° to 30°, has a ¾-inch radius superior condylar tracking surface, adjustable horizontal inclination from 0° to 90°, and latches. [8]

HANAU H2-O ARTICULATOR (Programming the Articulator)

Mounting the maxillary cast

The posterior reference points are located arbitrarily by inserting the plastic earpiece of both ends of the facebow into the patient's external auditory canals. The axis-orbital plane is established by connecting the posterior reference points to the anterior reference point. The orbital indicator is positioned on the patient's right side to contact the right orbitale point. The prongs of the registration fork are warmed over a flame and inserted into the wax occlusion rim. The width of the facebow is adjusted so that the condylar rods are symmetrically placed in their contact with the posterior reference points. Subsequent equalized adjustment of the rods to the articulator condylar posts will maintain the symmetry of the mounted maxillary cast. [9] [10]

Before mounting the casts, the articulator should be adjusted. The protrusive condylar guidances are set at 30°, the lateral condylar posts at 15°, the incisal pin to 0, and the incisal table is locked in a horizontal position.

Both centric locks should be tightened so that the condylar elements do not move. After transferring the facebow to the articulator, the condylar rods are adjusted equally to engage the condylar posts. The tip of the orbital pointer is brought into contact with the under surface of the axis-orbital plait indicator attached to the upper articulator frame. The facebow height is adjusted by turning the elevating screw under the lock clamp for the registration fork. A cast support is adjusted to protect the occlusal fork from any distortion caused by the weight of the maxillary cast and the mounting dental stone/plaster. Minimal expansion slurry- activated stone is added to the cast to complete the mounting procedure. [11]

Mounting the mandibular cast

The tentative centric relation registration is made with a pressureless impression paste such as zinc oxide eugenol or any rubber based impression material. Initially, the

upper wax rim is indexed with several V-shaped notches. The lower wax rim is reduced approximately 1.5 to 2 mm and then cross-hatched with a blade to form undercuts on the wax surface. After the registration is made, both baseplates are removed and seated on their respective casts. The incisal pin is set to 0 and both casts are related through the zinc oxide paste record. Minimal-expansion stone is added to the base of the mandibular cast and the articulator is closed.

Adjustment of the articulator

The protrusive occlusal record is used to set the instrument guides. An extraoral tracer can be attached to the wax occlusion rims with the central bearing plates set at the desired vertical dimension. The patient is encouraged to make various border movements like protrusive, right and left lateral movements while the pin touches the recording plate with light pressure. With the extraoral tracing assembly, the clinician can visualize the apex created that indicates centric relation [10]. An accurate record can be made by injecting quick-setting stone between the occlusion rims while the patient maintains the centric relation position. This record can be used to verify the tentative centric relation or for remounting to a new relation.

The protrusive occlusal record is also made with stone as the patient maintains the mandible approximately 6 mm forward of centric relation as determined by the tracing. The record helps in relating the split maxillary cast to its mounting stone base [12]. The condylar thumbscrews are loosened, and the incisal pin is raised. With the casts firmly seated in the stone protrusive record, the slope of the condylar path is adjusted until the cast is accurately keyed to the mounting base. After recording the horizontal condylar guidance, the formula L = H/8 + 12 is used to calculate the lateral condylar guidance. According to Hanau, this formula has been used satisfactorily in determining the lateral inclinations since 1922. In the formula, L = lateral condylar inclination in degrees and H = horizontal condylar inclination in degrees as established by a protrusive relation record. The lateral condylar posts are rotated to the desired angulation in degrees and this position is maintained by tightening the thumbscrews. [13] The approximate Bennett angle is determined and recorded.

WHIP MIX ARTICULATORS

The Whip-Mix Articulator

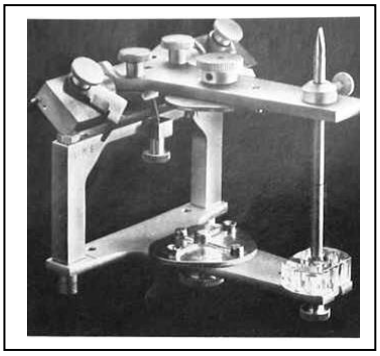
In 1964, Charles E. Stuart designed the Whip-Mix articulator. It is a semi adjustable arcon type which is a simpler version of Stuart's fully adjustable articulator. The condylar element of this instrument can be adjusted in the vertical and horizontal axis but not in the sagittal axis.

Several models of Whip Mix articulators are available that vary slightly in dimensions and their capabilities.

The Whip Mix Model 8500

The condylar elements that are present on the lower member can be adjusted to three positions. The narrowest intercondylar position is 96 mm, the intermediate distance is 110 mm, and the widest distance is 124 mm. The condylar guides in the upper frame are aligned with the condylar elements of the lower frame by either removing or adding the appropriate number of spacers on the shaft of the condylar

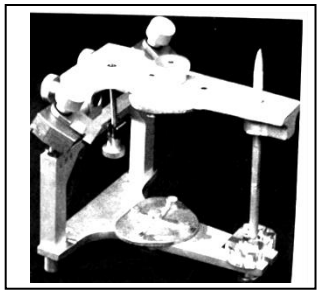
guides. The condylar guides are adjustable from a 0° to 70°. The medial walls can be adjusted from 0° to 45° to provide a progressive side shift. (Fig. 3)



(Fig. 3)

The Whip Mix Model 8800

In this instrument there is an extra ½ inch space for the mounting of maxillary cast. It is useful in conditions with extremely steep occlusal plane or in the presence of any osseous defect of the maxilla. Model 9800 is a combination of the upper member of model 8800 and lower member of model 9000. This provides greater distance between the upper and the lower members. (Fig. 4)



(Fig. 4)

The Whip Mix Model 8300

This articulator was made by Lundeen, Wirth, Lee, and others. There are ¾-inch curved superior walls of the condylar guides along with immediate side shift adjustments from the range of 0 to 4 mm and a progressive angle of 7½º on the medial wall.

It has a condylar locking screws, a centering guide pin, and the condylar elements are fixed at 110 mm.

Whip Mix Model 8340

It offers a modified version of the model 8300 articulator that allows interchangeability of casts between articulators.

Every articulator is manufactured with a specific mounting plate table attached to its lower member with a specific fixture called the Accumount. The relationship between the upper and lower frames is then individually checked to verify precise alignment.

Whip Mix model DB 2000 and DB 2200

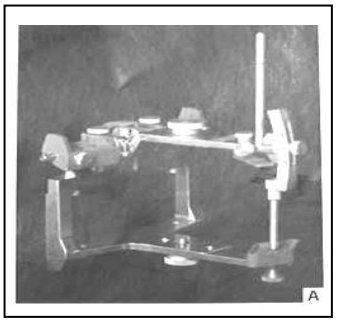
They are the latest articulators which also have an interchangeable 2240 model. All three instruments show an entirely new ergonomic upper and lower frame design.

PANADENT ARTICULATORS

A series of statistically selected three-dimensional analogs of condylar axis motion has been developed. The analog fossae have a curvilinear protrusive and mediotrusive paths of approximately ¾-inch radius.

There are five pairs in the set with side shifts of 0.5, 1.0, 1.5, 2.0, and 2.5mm and a 6° progressive angulation.

The Panadent articulator was designed in 1978 and the introduction to the current models were done in 1983. The most prominent change in the latest models were the presence of a mechanical latch. This latch holds the upper and lower members together yet allows it to open at 180º movement. (Fig. 4)



(Fig. 4)

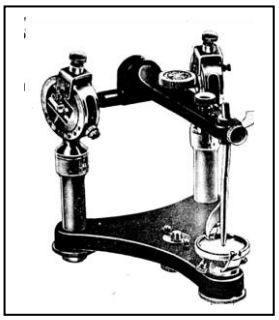
The articulators use ¼-inch condylar elements, instead of the usual ½-inch size, which are fixed at a 110-mm distance. There are three models—SL, PSL, and PCL.

The system was designed to select the correct analog and to determine the condylar path inclination with an extraoral quick analyzer tracing device. [14]

DENTATUS ARTICULATORS

This brand of articulators is manufactured in Sweden. All the models are axle-type instruments so that the condylar element can make rectilinear movements within a slot present in the condylar assembly. The ARH, ARL, ARS, and ARD models have the condylar elements as part of the upper frame and the condylar guidance on the lower frame.

The ARH model (1944) has all the features of the ARH model plus a gauge block to ensure basic measurements for coordinating work between dentist and laboratory articulators. The ARH is the original Dentatus articulator. It has orbital indicator, adjustable condylar guidance from -60º to +60º and has a sideshift adjustable from 0º to 40º. (Fig. 5)



(Fig. 5)

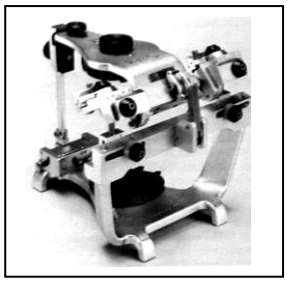
The ARL model (1958) This non-arcon model was introduced in 1958. It has calibrated condylar axis rods which can be used with a hinge axis technique. condylar guidance is adjustable from -60° to + 60° and has a side-shift angle of 0° to 40°, calibrated anterior stop screws, calibrated axis extension rods, an adjustable metal incisal guide table, and a curved incisal guide pin.

The ARS model has fixed condylar guidance features of 30ºtract inclination with a 15º Bennett angle and auditory pins to receive an ear face-bow. The guidance slot is open on the posterior aspect which lets the upper frame separate from the lower frame. [15][24][25] It has a flat and a 10º incisal guide table.

DENAR ARTICULATORS

The Denar Model D4a Articulator (1968)
In 1968, Niles Guichet developed this articulator. It is programmed using tracings that are recorded by a pneumatically controlled pantograph.

DENAR D5A- This is the current model which is a refinement of the original one (Fig. 6). Guidance can be adjusted in all three planes of space.



(Fig. 6)

The side shift (Bennett Movement) adjustment is in the medial wall and can record both immediate as well as progressive side shifts. A precurrent (angular) insert for the medial wall and inserts for superior wall is also available which are made of nylon or acrylic resin.

In various articulators, anatomic landmarks are utilized to establish the anterior and posterior reference points. Hence the Denar Reference Plane Locator and Marker are used to relocate the anatomic reference points accurately. [16] [17]

Denar Mark II (1975) - This articulator was introduced in 1975 (Fig. 7). It is a two-component instrument with a positive locking mechanism which holds the upper and the lower member together and permit 85 degrees of hinge movement. The horizontal condylar inclination is adjustable from 0º to 60º. Immediate side shift (Bennett) is adjustable from 0 to 4 mm and progressive shift is adjustable from 0º to 15º. Intercondylar distance is fixed at 110 mm but an adjustable intercondylar distance apparatus (110-122 mm) is also available.

(Fig. 7)

The posterior fossa wall has a 25º posterior inclination which permits the rotating condyle to move backward as it moves outward during lateral side shift. A straight rear wall option is also available. [18] [19]

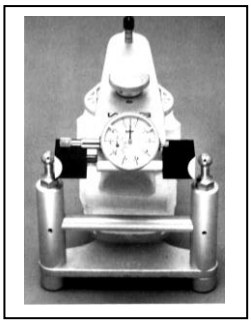
The Omni Articulator was introduced in 1984. This articulator can convert from closed track fossa to open track fossa using a positive locking latch. This feature fulfils the requirements for the fabrication of removable, fixed and complete dentures in one articulator. The Omni model is adaptable to a wide range of accessories of other models that can maximize its versatility.

SAM ARTICULATORS

This German articulation system is durable, stable, and precise. One aspect of its popularity is the ability to interchange mounted casts from one instrument to another.

The SAM 2 articulator (Fig. 8) has three interchangeable condylar housings that incorporate different curvatures to the superior wall. The curved surface produces a relative change of inclination, depending on the character of the curvature. [20] For instance, with housing 1, set at 45° at 3-mm protrusion, the angle will be 50°. With housing 2 set at 10 mm, the inclination will be 45° and with housing 3, set at 30° and at 3 mm advancement, the angle will be 55°.

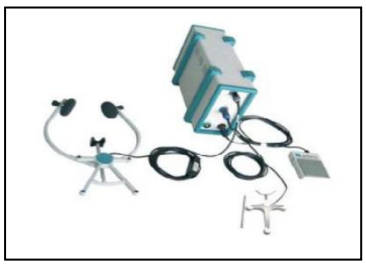
The face bow is very similar to the ear-bow by Whip-Mix and Panadent.[22][23]



(Fig. 8)

VIRTUAL ARTICULATORS [27]

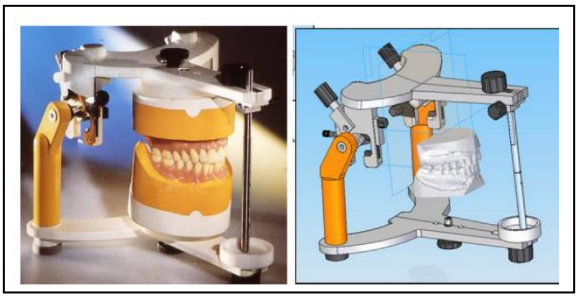
Virtual articulators are commonly known as "Software Articulators". They are not mechanical devices, but they exist as computer software or program. They consist of virtual- condylar and incisal guide planes. A device called the Jaw motion analyzer is used to measure patient parameter precisely which are then transferred to the system. Similar to an average value articulator, some articulator software is set with average values to determine the guide planes.



(Fig. 26)

Virtual models based on mechanical dental articulator (Fig. 27):

Its introduction was done in 2009. The concept was to develop various virtual articulators based on the mechanical models. By this the operator can choose which parameters are to be registered from the patients and can be used to compare the virtual and mechanical articulators for their adequacy. It is known for its simplicity which makes it easier for the user to choose an appropriate articulator for jaw simulation.



(Fig. 27)

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