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## Articulators- A review article

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### Abstract

It is well adjudged that the mouth comprising bi-maxilla and the two temporo-mandibular joints as the best articulator. But due to the innumerable procedures carried out to fabricate a prosthesis, a mechanical device stimulating the two jaws and the temporo-mandibular joints are needed for ease of work and comfort of the patient. This device is called and "ARTICULATOR".

**Keywords:** Articulator, Facebow, Prosthesis, Mandibular Movements.

### 1. Introduction

Articulator is a mechanical device that represents the temporo-mandibular joints and the jaw members to which maxillary and mandibular casts may be attached to simulate some or all the mandibular movements. Many devices that are called articulators do not satisfy this definition. Some of these devices make no attempt to represent the temporo-mandibular joints (face bow transfer) or their paths of motion (eccentric registration) <sup>[1]</sup>. Some instruments allow eccentric motion determined by inadequate registrations (positional registration). Some utilize average or equivalent pathways. Some attempt to reproduce the eccentric pathways of the patient from three dimensional registrations. Some other articulators record even the fourth dimension, i.e., the timing of the Bennett movement <sup>[2, 3]</sup>.

### 2. Literature Review

The history of articulators parallels that of the varying concepts of occlusion. Attempts were made to record anatomic relationships of reproducing functional movements of the mandible and transfer this to the mechanical devices to stimulate the conception of natural movements. More sophisticated instruments evolved as more learned about the anatomy, mandibular movements and mechanical principles. The objective was always the same: to produce or reproduce occlusal relationships extraorally. The plaster articulator devised by Philip Pfaff in 1756 consisted of the plaster extension on the distal portion of maxillary and mandibular casts grooved to each other. This was commonly known as slab articulator <sup>[4, 5]</sup>.

The first mechanical articulator was described in 1805 by J.B. Gariot. He designed the hinge joint articulator which consisted of two metal frames, to which the casts were attached, a hinge to join them and set crew to hold the frames in a fixed vertical position. In 1840, Cameron and Evans made attempts to device the plane line articulator <sup>[6]</sup>. Bonwill, a mathematician, in 1858 developed an articulator based on his theory of occlusion on the theory of equilateral triangle, with which he demonstrated the anatomic and balanced occlusion. W.E. Walker in 1896 said that dentures, which balanced on Bonwill's articulator did not balanced in the mouth and pointed the absence of condylar inclination as the dictating factor <sup>[7]</sup>. He devised the Clinometer which had provision for gothic arch tracings. Rudolph L. Hanau, an engineer, during the time of First World War in 1921 developed a research model called the Hanau Model C Articulator which had provision for controlled movement with more accurate and accessible controls, and its adjustments and operation much simplified. Later in 1923, he devised the 'Kinescope' which provided exact measurement of mandibular movements. In the later years, Hanau introduced more measurements such as model 110 which had individual condylar guidance adjustments in both sagittal and horizontal planes and the lateral condylar angle calculated by the formula  $L = H/8 + 12$ , H = Horizontal condylar angle <sup>[8]</sup>.

### 3. Clinical Implications

The articulator is a rigid device with movement patterns determined by solid pathways, whereas the mandible is guided by muscles, ligaments and non-rigid joint surfaces, by the teeth and by complex neuro-muscular system. The mandible suspended by the ligaments and muscles is resilient and flexes under normal biologic stresses and the teeth are suspended in the membranes that respond to stresses in an elastic manner. The more adjustable the articulator, the factors of mandibular movements can be reproduced with a greater degree of accuracy. At the same time, more complicated the device, more the human errors involved [9, 10].

### 4. Uses

Articulators are used to mount diagnostic casts, to study the occlusion of a patient and as an aid in planning treatment procedures. It is used to hold the opposing casts in a predetermined fixed relationship. As an aid in the fabrication of dental restorations and lost dental parts. In the arrangement of artificial teeth for complete dentures, removable partial dentures and waxing in field partial dentures.

### 5. Limitations

An articulator is a mechanical instrument. It is subject to error in tooling and errors resulting from fatigue and wear. An articulator can stimulate but not duplicate jaw movements. Since the articulator may not reproduce exactly intraborder and functional movements, the mouth would be the best place to complete the occlusion, but using the jaws as an articulator also has limitations: Inability of humans to detect visually the finer changes in the motion. Making accurate marks in the presence of saliva. Exact location of the condyles. The resiliency of the supporting structures. The dentures are movable. Effectiveness of an articulator depends on the person who understands its constructions and purpose, the anatomy of the joints, their movements and the neuromuscular system, precision and accuracy in registering jaw relations and the sensitivity of the instrument to record these.

### 6. Classification

Articulators based on theories of occlusion [11].

#### A) Bonwill's Theory of Occlusion

Teeth move in relation to each other as guided by the condylar control and the incisal point. It is also known as the theory of equilateral triangle which has a 4 inch (10 cms) distance between the condyles and between each condyle and to the lower central incisor point. eg: Bonwill's articulator, Gysi simplex articulator. Since condylar guidances were not adjustable, the only movement in the horizontal plane is permitted.

#### B) Conical Theory of Occlusion

Lower teeth move over the surfaces of the upper teeth as over the surface of a cone, with a generating angle of 45 degrees and the central axis of the cone tipped at 45 degrees to the occlusal plane. eg. Hall Automatic articulator-teeth with 45 degrees cusps were necessary for constructing dentures on this type of articulator.

#### C) Spherical Theory of Occlusion

Proposed by G.S. Monson in 1918. The lower teeth move over the surface of the upper teeth as over the surface of a sphere with a diameter of 8 inches (20cms). The center of the sphere

is located in the region of the glabella and the surface of the sphere passes through the glenoid fossa along the articulating eminences or concentric with them. This theory was based on observations of natural teeth and skulls by Von Spee, a German anatomist. eg: Monson's Maxillo-Mandibular Instrument. The failure of these articulators based on theories is because of one common fault – provision was not made for variations from the theoretical relationship that occurs in different persons.

Articulators based on the types of records used for their adjustment: [12].

### 7. Interocclusal Record Adjustment

In this type only one potential relationship is possible in centric, protrusive and centric or lateral relation. Teeth casts on the articulator are accurate only in that position where the interocclusal records are made. The mechanical features that determine whether or not an articulator can be adjusted to accommodate interocclusal records include - Include adjustable horizontal condylar guidances. Variable control for the Bennett movement. Variable intercondylar distance. Split axis condylar guidance controls and adjustable incisal guidance control.

#### B) Graphic Record Adjustment

Since the border movements of the mandible are curved and are recorded graphically, the articulators also should be capable of producing or simulating these curved movements. These recordings are difficult and unreliable in edentulous patients.

#### C) Hinge Axis Location for Adjusting Articulators

The correct location of the opening axis of the mandible should be made, if not, the correct adjustment of these instruments is impossible.

III: According to the International Prosthodontic Workshop on Complete Denture Occlusion at University of Michigan in 1972.

#### Class I

Simple holding instruments capable of accepting a single static registration. The first articulators were coined as "SLAB ARTICULATORS". Plaster indices extended from the posterior portion of the casts and were keyed to each other by means of these indices. eg: J.B. Gariot's hinge articulator (1805).

#### Class II

Instruments that permit horizontal as well as vertical motion but do not orient the motion to the temporo-mandibular joint with facebow transfer.

#### Class – II – A

Permit eccentric motion based on average or arbitrary values. In this type, the condyles are on the lower member and their paths are inclined at 15 degrees. Casts are mounted to this articulator according to Bonwill's theory. eg: Gritmann articulator (1899). Alfred Gysi' Simplex articulator (1914). This has the condylar path inclined at 30 degrees and the incisal fixed at 60 degrees.

#### Class II- B

Permit eccentric motion based on arbitrary theories of motion. eg. Maxillo-mandibular instrument designed by Monson in 1918 based on his spherical theory of occlusion.

### **Class II-C**

Permit eccentric motion based on engraved records obtained from the patient.

### **Class Iii**

Instruments that simulate condylar pathways by using average or mechanical equivalents for all or part of the motion and allow for joint orientation of the casts with a facebow transfer.

### **Class – Iii – A**

Accept facebow transfer and a protrusive interocclusal record. eg. Hanau Model H designed by Rudolph Hanau in 1923 Dentatus articulator (1944). Bergstrom's Arcon articulator designed in 1950 similar to Hanau H, except that the condyles are on the lower member and the condylar guides are curved and are on the upper member. Bergstrom's instrument was not the first Arcon instrument, but he was the first person to coin the "ARCON". These instruments have condyles on the lower member and the condylar guides on the upper member.

### **Class- Iii – B**

Accept face-bow transfer, protrusive interocclusal records and some lateral interocclusal records. eg: Gysi in 1926 introduced the Trubyte articulator. It is a non-arcon instrument with a fixed intercondylar distance. The horizontal condylar inclinations are individually adjustable, and the individual Bennett adjustments are located near the center of the intercondylar axis. The incisal guide table is adjustable.

### **Class – Iv –1**

Instrument accepts three dimensional dynamic registrations and utilizes a face-bow transfer.

### **Class-Iv-A**

The condylar pathways are formed by registrations engraved by the patient. eg: TMJ instruments designed by Kenneth Swanson in 1965.

### **Class –Iv – B**

Condylar pathways are selectively angled and customized. eg. Gnathoscope designed by Charles Stuart in 1955, Niles Guichet in 1968 designed the Denar (D4A) fully adjustable articulator. The latest instrument in Denar series is D5A which has the plastic condylar inserts. This has provision for a both immediate and progressive side shift Bennett adjustment.

## **8. Discussion**

Evolution of articulators through the years has given an insight of the researchers trying to develop a mechanical device that simulates the jaw members and its movements. The purpose of using an articulator is to develop a prosthesis that will be harmonious in the oral cavity. Various articulators have been developed and are being improved upon as and when the functions of the jaws are understood better. Accordingly, in the present day, the availability of articulators range from simple hinge type to fully adjustable articulators. Selection of articulators depends upon the clinical situation. In complete denture prosthesis, semi-adjustable articulators suffice the requirements to develop a good denture. Fully adjustable articulators are used for fixed prosthesis. It is difficult to manage fully the adjustable articulators in complete denture patients because the clutches used to obtain the hinge axis and condylar movements are more cumbersome to be used in edentulous patients which in turn do not provide accurate records.

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