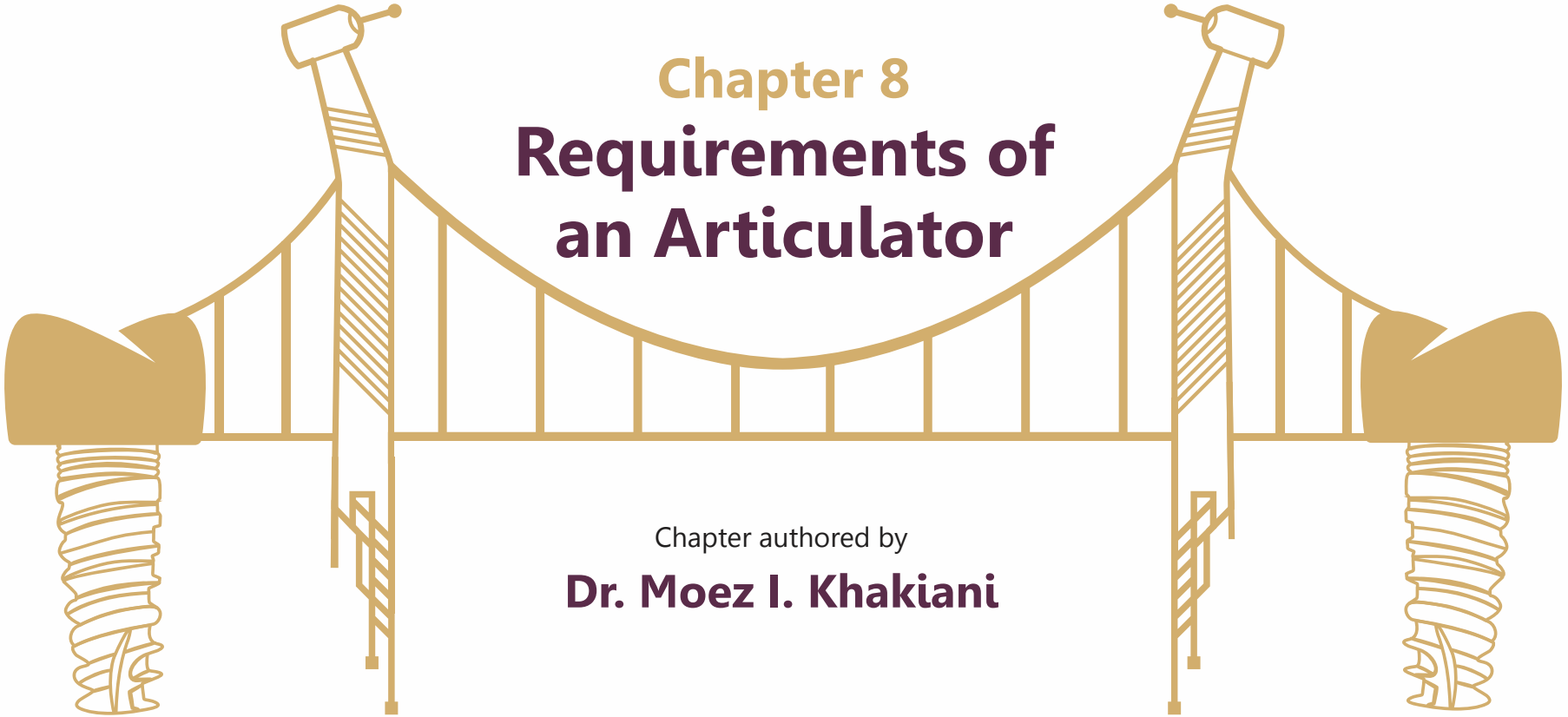

Chapter 8

Requirements of an Articulator

Chapter authored by

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A GOOD tool improves the way you WORK ,
A GREAT tool improves the way you THINK
- Jeff Duntermann

Let me start this chapter by stating the obvious; 'Joint position determines tooth position' and on the same grounds, 'Orthopaedic stability is paramount for achieving orthodontic stability'.

On this premise, unmounted casts that are examined using 'hand articulation' have no role to play in reconstructive dentistry. This is because, a major component of occlusion, i.e. the TMJoints get completely neglected.

Fig. 8.1, 8.2: Hand held casts (left) are equivalent to a patient with no TMJ (right).

Diagnostic casts mounted on an articulator using a facebow and CR record allow us to evaluate the patient's bite in the MS position, regardless of how teeth meet in their maximum intercuspal position. Hence, diagnostic mountings are the best place to:

- ★ Repeatedly analyze the true mandible-to-maxilla relationship,
- ★ Determine the ideal vertical dimension in occlusion,
- ★ Diagnose the missing essentials of occlusal stability, and
- ★ Design a definitive treatment plan.

Fig. 8.3, 8.4: Left: Bite in MIP with displaced condyles, Right: Occlusion when the condyles are in their CR position. Note, how tooth-to-tooth relationship changes when condyles are seated in their 'home' position. Casts mounted on Corident CSA 400 semi-adjustable articulator.

The primary purpose of analyzing diagnostic casts is to observe the dynamic tooth-to-tooth relationship in CR, at different vertical dimensions. Mounted casts make it possible to determine the best treatment approach for achieving the desirable CR=MIP relationship.

? Which articulator should be used for full mouth reconstruction cases?

Contrary to what many imagine, mandible does not open and close along a straight path. It rather moves along an arc; such that when the mouth is opened, the lower incisal edges move backward and downward (away from anterior contact) and conversely, when the mouth is closed, the lower incisal edges move forward and upward (towards their antagonist teeth). This has an impact not just on anterior relationship, but also the bucco-lingual alignment of posterior teeth.

Articulators vastly differ from each other in reproduction of this arc of mandibular movement.

Fig. 8.5: Geometrically correct articulator (Corident CSA 400) superimposed onto the patient's face. Note, the distance from the condylar centre to the maxillary incisal edge (yellow line) is accurately reproduced on a semi-adjustable articulator, where the maxillary cast has been mounted using a facebow record.

Fig. 8.6: Geometrically incorrect 2-point articulator superimposed onto the patient's face. Note the physiologically unacceptable location of hinge axis and its distance from the maxillary incisal edge position.

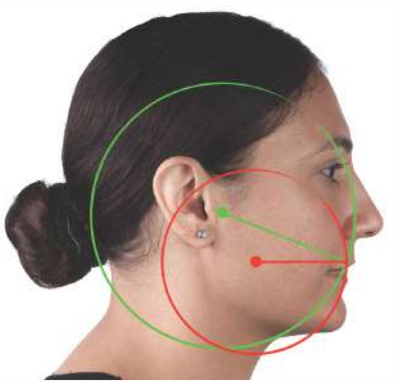

Fig. 8.7: As the radius of a 2-point articulator is far from physiologic, the arc of opening-closing on the articulator is far more vertical (red), than that followed by the semi-adjustable articulator (green). Such a discrepancy has negative implication when VDO is altered, making it an unacceptable articulator for reconstruction of the entire dentition.

The choice of articulator in full mouth prosthetic reconstructions, is as important as the choice of footwear when running a marathon. Hence, a basic understanding of the instrument is needed before choosing or using it.

Any articulator (regardless of its design complexity or price), is a mechanical equivalent of the human stomatognathic system, and allows us to simulate (within limitation) movements made by the mandible.

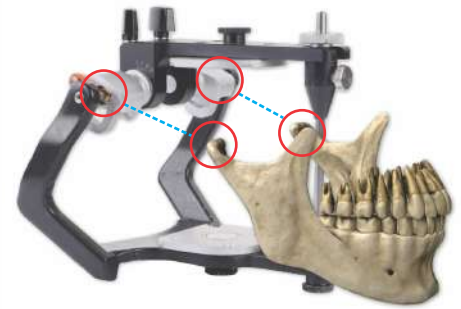

Fig. 8.8: An articulator is designed to replicate the skeletal form.

Articulators that are used for rehabilitation cases can be broadly clustered into the following 3 categories, based on how accurately they reproduce the patient's condylar movements:

- ★ Fully adjustable articulators- most accurate
- ★ Semi adjustable articulators- moderately accurate
- ★ Mean value articulators- least accurate

Note: Although fully adjustable articulators are the most precise in terms of duplicating the condylar movements, they can almost never replicate anatomy with all its micro-variations.

Fig. 8.9, 8.10: Regardless of the complexity/sophistication of an instrument, the condylar ball on the articulator is always 'round' and not shaped like the anatomically irregular condylar head. Additionally, the glenoid fossa anatomy can rarely be copied (with all its disparities) onto a machined equivalent.

With this in mind, let us begin answering the question, 'Which articulator is best suited for reconstruction cases?'.

Fully Adjustable Articulator vs Semi Adjustable Articulator

During the gnathological era, use of complex fully adjustable articulators was considered an 'absolute necessity' for reconstruction cases, along with:

- ▶ A kinematic facebow for precise location of the terminal hinge axis position, and
- ▶ A pantographic record for accurate tracing of the condylar paths.

Proponents of the gnathological principles incorrectly believed that:

- ▼ Condylar guidance was the sole determinant of occlusal anatomy,
- ▼ Anterior guidance was not significant, and could be arbitrarily set,
- ▼ Immediate side shift was physiologic, and needed to be incorporated into the design of the articulator,
- ▼ Occlusal contacts needed to have a tripod effect, Fig 8.11
- ▼ Bilaterally balanced occlusion was a must during lateral excursion,
- ▼ Occlusal adjustments had to be done on fully adjustable articulators, and could not be performed intraorally.

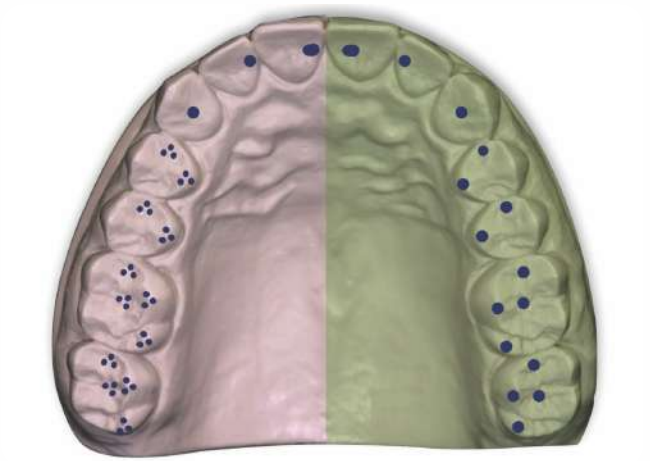

Fig. 8.11: Left half: Occlusal scheme as per gnathology with tripodization of posterior occlusion, accounting to ≈ 200 static points of contact, Right: Occlusal scheme as per cusp tip-to-fossa philosophy that is currently followed. Gnathological principles required occlusal contacts to occur on the sides of cusps and the walls of fossae to form a tripod arrangement. As can be imagined, achieving this would be extremely difficult and would require tremendous skill and patience for successful execution. Gnathology gurus proposed that such an arrangement guarantees a 'wear-free' occlusion.

Over time, most of these principles of gnathology were deemed unnecessary or incorrect. As new understanding about functioning of the stomatognathic system came to light, multiple occlusal principles of the gnathological era were replaced by the following (current) beliefs:

- Anterior guidance is independent of condylar guidance,
- If anterior guidance can be designed to provide posterior disclusion, the dependence on condylar guidance can be substantially reduced,
- Immediate side shift cannot occur from a bone-braced condylar position, i.e. CR,
- Bilateral balanced occlusion is traumatic for the natural dentition, and the mutually protected occlusal scheme is most physiologic,
- Cusp tip-to-fossa contacts are stable and far easier to design as compared to tripod contacts,
- Occlusion can be tested and adjusted intraorally during the bisque trial phase.

Current occlusal philosophies rightly believe in the role of anterior guidance as the primary determinant of posterior cuspal anatomy and posterior disclusion patterns. A patient's anterior guidance is part of his/her envelope of function, which in itself, is a subset of their envelope of motion (explained on page 38). Because anterior guidance is functionally generated and unique to each individual, it can only be customized intraorally. In this regard, not even the most sophisticated fully adjustable articulator, with the most detailed recording of condylar guidance can ever be relied upon.

As the importance of anterior guidance was understood, the dependence on condylar guidance reduced. With this, the compulsive use of complex fully adjustable articulators also diminished.

Owing to this paradigm shift in understanding of the biologic system, the dramatically simpler semi-adjustable articulators came into vogue, which allowed analysis of interarch relationships, determination of vertical dimension, establishment of centric contacts and designing of excursive pathways to be performed with an acceptable degree of accuracy. This holds true even for the most complex cases, making semi-adjustable articulators 'the instrument of choice' for full mouth reconstructions.

? Can a mean value articulator be used for full mouth reconstruction cases?

The mean value articulator is designed on the basis of 'Bonwill's equilateral triangle', which states that the average distance from the mandibular central incisor to the condyles on both sides is equal to the inter-condylar distance.

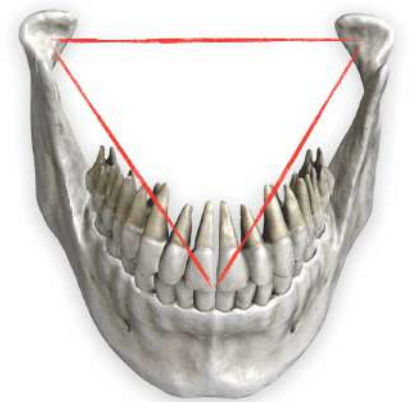

Fig. 8.12: Note the equilateral triangle created between the lower incisor midline and the two condylar heads.

Fig. 8.13: The mean value articulator is designed with three equal sides. This is the reason why maxillary casts (and complete denture wax rims) are mounted such that their front edge contacts the tip of the incisal cross-pin.

Listed below are some inadequacies of a mean-value articulator:

- The articulator is designed with sides that measure ≈ 4 inches or 100 mm. Although this value is roughly correct, it is an oversimplified average that does not hold true for all patients.
- Most mean value articulators do not accept a facebow record, which is one of its biggest drawback.
- They have a pre-fixed condylar guidance angle, which is often greater than acceptable for reconstruction cases.

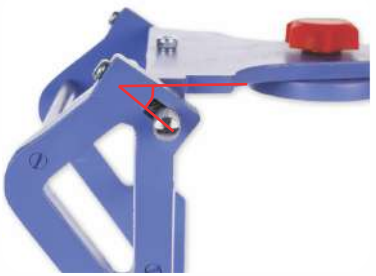

Fig. 8.14: The condylar guidance path is pre-fixed at ≈33° and cannot be changed when required.

- They have a pre-fixed incisal guidance angle (≈9 to 12°) which is unacceptable, as anterior guidance is highly variable and needs to be customized for each patient.

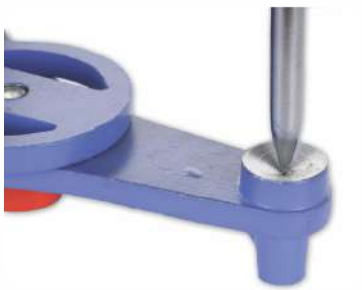

Fig. 8.15: The incisal table is not removable and designed with a pre-fixed slope, making it difficult to customize the anterior guidance.

Owing to the above mentioned shortcomings, a mean value articulator is 'not recommended' for tooth supported full mouth reconstructions.

? What are the recommended requirements for a semi-adjustable articulator to be used for FMR cases?

Amongst the numerous requirements (listed on page 215), the two most important ones include:

A. It must accept a facebow transfer, and

B. It must have adjustable condylar paths.

A. IT MUST ACCEPT A FACEBOW TRANSFER

? What is the role of a facebow?

Why do we need to take facebow records for reconstruction cases?

Facebow record and transfer is an integral part of reconstructions and working with semi-adjustable articulators.

A facebow serves two primary purposes:

a. Recording the condylar hinge axis position and transferring it onto the articulator, and

b. Recording the spatial orientation of the maxilla with respect to the cranial base.

a. Recording the condylar hinge axis position and transferring it onto the articulator.

The most important purpose of an articulator is to relate the mandibular cast to the maxillary cast in centric relation and permit a change in vertical dimension, without loss of inter-arch accuracy. Facebow is a fundamental tool in fulfilling this primary requirement.

Alterations in VDO are a mainstay of almost all reconstruction cases. Remember, diagnostic CR bite records are always made with teeth apart (as explained on page 234), which means they are recorded (and casts are mounted) at an increased vertical. This means, once the CR record is removed (after mounting), the vertical on the articulator would have to be dropped/decreased until stone-to-stone contact at RCP is achieved. At this dimension, we have to make a decision whether this VDO is adequate for reconstruction, or would it have to be increased by opening the articulator, as described on page 289. This is a tricky situation, as even small changes in vertical can have a large impact on how teeth articulate with each other.

Now imagine opening the jaw to record the CR along the patient's condylar axis of rotation and then closing it on the articulator at a different axis of rotation. Would this not create a geometric error?

The only way to predictably alter vertical dimension without inducing errors, involves recording CR along the patient's hinge axis, and then closing the vertical on the articulator 'along the exact same axis'. This is where a facebow record steps in, as it fulfils this very requirement.

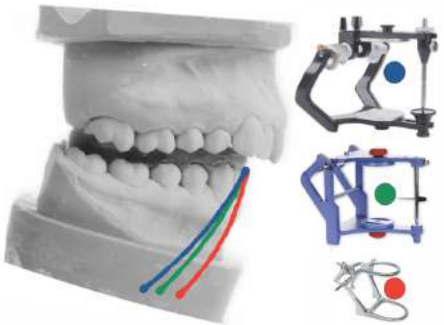

Fig. 8.16: Arc of rotation for three different articulators overlapped. Note the marked difference in the profile of opening, with a change in the hinge axis position. This proves without doubt, that it is geometrically impossible to open along one axis and then close along a different axis, and expect consistent results. Hence, restorations fabricated along an incorrect arc on the articulator, would most definitely result in interferences intraorally.

If you are faced with a scenario where occlusal intercuspation looks perfect on the articulator, but when introduced into the patient's mouth results in as an anterior open bite (with only terminal molar contact), it is safe to conclude that the case was constructed along the wrong arc, because a facebow record was either not taken correctly, or not transferred properly onto the articulator.

Fig. 8.17, 8.18: Facebow records the distance of the maxilla from the patient's CR axis (left), and relates this orientation to the CR axis of the Corident CSA 400 articulator (right).

Following maxillary mounting using a facebow transfer, when the mandibular cast is mounted to the articulator using the CR record, it automatically gets related to the mechanical condylar axis of the articulator. This is loosely based on the 'law of transitivity', which states that if 'a' relates to 'b' and 'b' relates to 'c', then automatically 'a' relates to 'c'. This allows the physiologic arc of mandibular opening-and-closing to be duplicated as the mechanical arc of opening-and-closing on the articulator.

Fig. 8.19, 8.20: Condylar axis= a, maxillary cast= b, mandibular cast = c. Left: Facebow relates the condylar axis (a) to the maxillary cast (b), Right: CR record relates the mandible (c) to the maxillary cast (b). This inevitably relates the mandibular cast (c) to the condylar axis (a).

This is the only way to identify (with certainty) the correct location of lower teeth in relation to the upper, when the mandible or articulator is opened-or-closed to the final VDO.

Fig. 8.21: When the opening-and-closing arc of the articulator coincides with that of the patient, the first purpose of a semi-adjustable articulator i.e. to relate the lower and upper cast to the condylar axis in centric relation is fulfilled. Remember, CR axis is a fixed axis and once transferred onto the articulator, VDO can be changed without the fear of inducing errors in the interarch relationship. With this achieved, any change on the articulator's vertical would match corresponding changes on the patient's vertical, and vice-versa.

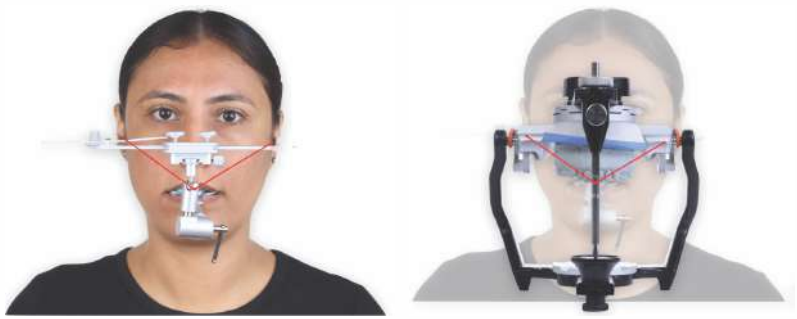

Fig. 8.22, 8.23: Facebow record when viewed from front. Left: Depicts the recording of distance from the ear opening to the maxillary midline; Right: The same record transferred accurately onto the Corident CSA 400 semi-adjustable articulator.

Note: Although the rotational axis of the condyles can change rapidly during function, only the CR axis is important to the articulator for establishment of static occlusal contacts. Thus when making any changes in the vertical dimension, it is imperative that the condylar ball be locked in home position (CR) with help of the centric latch.

Fig. 8.24, 8.25: Centric latch holding the condylar ball in centric relation. In this position, the articulator can only make hinge movements along the terminal arc of rotation. **Note:** This does not mean that the articulator or mandible is restricted to this centric relation axis of rotation. Both, the mandible and the articulator are free to hinge around any axis and move into any translatory position. However, locking the condylar ball precisely 'co-relates' a 'recordable' and 'repeatable' hinge axis position on the articulator, allowing us to alter the vertical.

Recording the condylar hinge axis position and transferring it onto the articulator is the first role of a facebow. Let us now address the second role.

b. Recording the spatial orientation of the maxilla with respect to the cranial base

Although maxilla is attached to the cranial base, there are multiple variations in its three-dimensional arrangement. Anthropological studies have revealed certain averages for maxillary orientation, as described below.

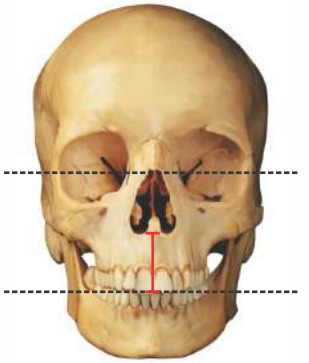

Fig. 8.26: Frontal view of the skull. Under ideal arrangement, the incisal plane is parallel to the inter-pupillary line and the average height of the maxilla along the midline is ≈30 mm (red line).

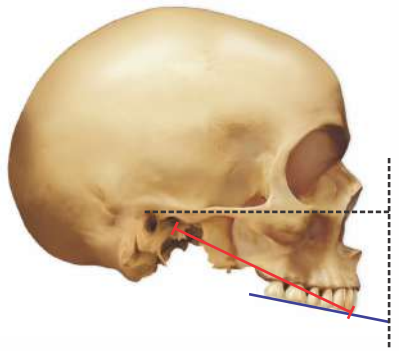

Fig. 8.27: Lateral view of the skull. Note the maxilla is never parallel to the Frankfurt horizontal plane, and the average angle of the maxillary occlusal plane is ≈ 10 to 15° (blue line). Also the average distance between the condylar axis to the incisor is ≈ 100 to 110mm (red line).

Being averages, these values do not apply to all humans. As each individual is anatomically different, every maxilla has a unique relation with the cranium.

- ★ Some humans have a long face, while others have short faces;
- ★ Some patients have a prognathic maxilla with a convex profile, while others have a mid-face defect with concave profiles;
- ★ Some patients have vertical maxillary excess, while others have maxillary deficiency.
- ★ Some patients may have an ideal incisal plane, while others have a side-to-side cant, resulting in aesthetic concerns.

Owing to these profound variables of maxillary position in all 3 spatial planes (sagittal, coronal and transverse), precise recording of the maxillary arch orientation becomes an essential step in functional and aesthetic reconstructions.

As maxillary cast mounting is the starting point of articulation, the accuracy of all other relationships depend on getting this requirement right.

Fig. 8.28-8.36: Note the variable position of maxillary (and accordingly) mandibular casts from different perspectives on a Corident CSA 400 semi-adjustable articulator. Top: Front-to-back, Middle: Side-to-side, Bottom: Superior-inferior view. A facebow helps record and relate these spatial variations to the articulator and helps to orient the maxillary cast in all 3 dimensions.

With aesthetics at the forefront, there are very few errors or inconsistencies that affect appearance more negatively than a canted incisal plane. Such problems can be avoided with use of a facebow by aligning the U-frame parallel with the inter-pupillary line. Such a set-up auto aligns the incisal plane parallel to the horizon, allowing the technician to correct a cant (when present) and more importantly, avoid creating one.

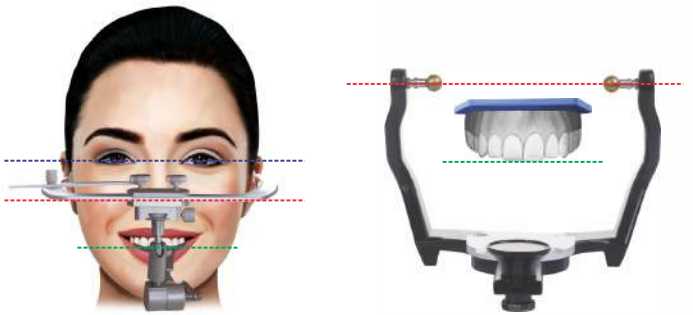

Fig. 8.37, 8.38: When a facebow record is made in such a way that the U-frame aligns parallel with the patient's inter-pupillary line (left), the maxillary cast gets automatically aligned with the inter-condylar axis of the articulator (right).

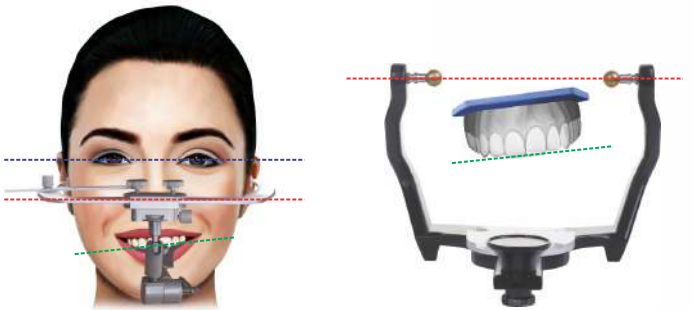

Fig. 8.39, 8.40: This becomes especially important in patients with a pre-existing cant, as alignment of the U-frame with the eyes results in a transfer of the true cant on to the articulator. This allows the technician to correct the anomaly and create an aesthetically pleasing incisal plane.

A concern arises when the patient's ears are not positioned along the same horizontal plane as the eyes. This means, when the ear-pieces are in position the U frame does not align parallel with the eyes. If this relation is transferred to the articulator, the maxilla would get mounted at an incorrect orientation, possibly resulting in major mishaps.

Fig. 8.41, 8.42: Note the canted orientation of U-frame in relation with the patient's inter-pupillary line. These are patients who have an anatomic variation in the position of their ears or eyes across the midline.

Fortunately, this issue can be tackled rather easily. Remember, the goal is to make the incisal plane parallel to the inter-pupillary line. So every effort should be made to align the U-frame parallel to the eyes. This is achieved by either raising or lowering the earpiece (within the external auditory meatus), until the desired parallelism is achieved, as shown above.

What is role of the anterior point of reference?

What is the ideal anterior reference point?

When mounting cases on the articulator, it helps to center the casts between the upper and lower member. The obvious reason for this is to provide adequate vertical room for mounting the maxillary and the mandibular casts, along with providing enough space for the mounting plates and the mounting plaster.

This involves the use of a third point of reference which is positioned anterior to the intercondylar axis. The most commonly used anterior reference point is the orbitale, as most articulators are designed around the Frankfurt horizontal (porion-orbitale) plane. The orbitale is identified via palpation of the infraorbital rim, which can result in subjective errors.

In order to overcome these, many facebow designs involve the use of nasion indicators or specially calibrated scales to establish a repeatable third point of reference. Fortunately, precision in their identification is not critical as these are reference points.

Fig. 8.43: Orbitale (red), Nasion (blue); two of the most routinely used anterior points of reference.

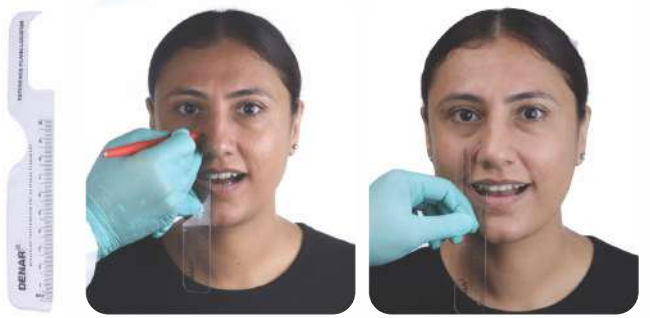

Fig. 8.44-8.46: The reference plane locator (Denar) is a special scale used to locate a point 23 mm above the edge of the right lateral incisor.

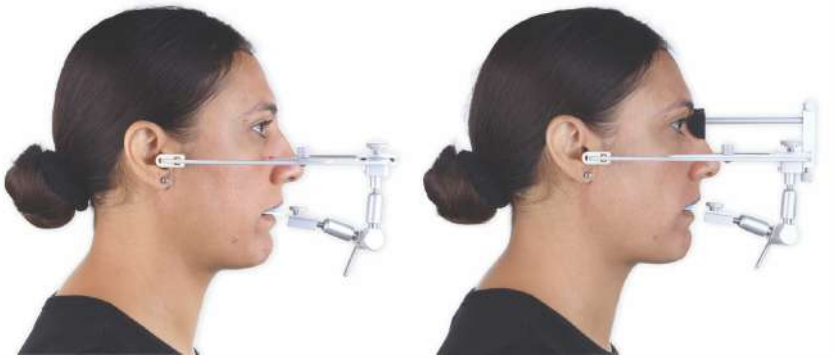

Fig. 8.47, 8.48: With the help of a third point of reference, the exact location of the maxilla can be triangulated in relation to the hinge axis. Both, orbitale (left) and nasion (right) are globally acceptable and can be chosen as per operator preference.

However, it is advisable to choose any one of these reference points and follow it for all cases, as this helps reproduce an accurate maxillary cast mounting in case a repeat transfer is needed.

? Is an earbow acceptable for facebow records?

Earbows are the fastest and easiest facebow designs for clinical use.

The question towards their acceptability arises because they use the inter-auricular axis, instead of the true inter-condylar axis to record the maxillary position.

Fig. 8.49: Anatomically, the auricular opening (red star) and condylar axis (blue star) are close to each other but never co-incident.

Despite some objections, literature states that an earbow assembly is accurate enough for routine use. This is because, every facebow system comes with its own 'indirect mounting jig' that typically attaches to the front end of the articulator and auto-compensates for the discrepancy between the condylar axis and the external auditory meatus position.

Fig. 8.50, 8.51: Indirect mounting jig attached at the front end of a Coridient CSA 400 articulator.

Remember, there is no need to complicate the facebow design. As described, it has two primary purposes which are easily fulfilled by even the most basic model. Additional features are typically added for either convenience or sales purposes. All earbow designs (from simple and cheap to the most complex and expensive ones) are acceptable, as long as they relate the upper arch to the condylar axis.

Details on how to record a facebow and transfer it to the semi-adjustable articulator are described in the chapter 9, on page 219.

After having discussed the first requirement, i.e. ability to accept a facebow record, let us now address the next important requirement of a semi-adjustable articulator.

B. IT MUST HAVE ADJUSTABLE CONDYLAR PATHS

As described in Master Level Occlusion, two quantifiable angles exist in relation to the condylar paths:

- ★ The horizontal condylar guidance angle (H), and
- ★ The lateral condylar guidance angle (L).

The Horizontal Condylar Guidance Angle (H)

The back end of the articulator is designed to duplicate the skeletal anatomy of the articular fossa. A semi-adjustable articulator should have a customizable glenoid fossa component, that allows for the horizontal condylar guidance angle to be altered as per requirements of the case.

Fig. 8.52, 8.53: A flatter horizontal condylar guidance angle (left) and steeper angle (right). Note the altered path taken by the condylar ball during translation.

Note: Having understood the importance of anterior guidance in FMR cases, our dependence on condylar guidance has (most definitely) reduced, but by no means eliminated.

As a general rule,

- ★ If the anterior guidance is functional and able to provide posterior disclusion, the role of condylar guidance is diminished.
- ★ If the anterior guidance is functional but unable to provide posterior disclusion, the role of condylar guidance becomes crucial, e.g. edge-to-edge bite, severe overjet, etc.
- ★ If the anterior guidance is non-functional, condylar guidance assumes the sole responsibility towards posterior disclusion, e.g. anterior open bite, anterior cross bite, etc.

In accordance with these rules, the following two articulation guidelines can be established:

Guideline 1: Cases where anterior guidance is able to provide the necessary posterior disclusion, H value can be pre-set (standardized) on the semi-adjustable articulator at 20°.

Literature states that horizontal condylar guidance angle is almost always greater than 20° (under non-pathologic conditions). This means, any wax-up or prostheses designed without posterior interferences on an articulator set at 20° horizontal condylar guidance angle, would automatically undergo 'greater separation' when placed in the mouth of a patient who has a steeper H angle.

In other words, if posterior teeth are designed with cuspal inclines that are flatter than the anterior guidance angle, disclusion in all excursive movements can be achieved by pre-setting the articulator at an H value that is flatter than what is expected on the patient.

Since almost all patients have H value that is greater than 20°, the articulator can be pre-set at this value for all cases where anterior guidance is functional and able to provide the necessary disclusive effect. This protocol of pre-setting the horizontal condylar guidance is very practical and not as random as it may seem.

Fig. 8.54, 8.55: With a smaller condylar guidance angle on the articulator (left), posterior restorations disclude with greater separation intraorally (safety factor), as the mandible begins to translate down a steeper disclusion pathway (right).

Note: Setting the condylar paths flatter on the articulator has no adverse effects on static occlusal contacts or dynamic mandibular movements, as long as the anterior guidance is providing the desired posterior separation.

Guideline 2: Cases where the anterior guidance is compromised or missing, H value should be precisely determined as we need to rely on the downward movement of condyles to bring about separation of posterior teeth during excursive movements.

A protrusive bite record is needed for this determination. The procedure for registering a protrusive bite and transferring it onto the semi-adjustable articulator is described on page 271.

It is noteworthy, that the greatest angle of disclusion is present at the very beginning of the translatory movement, where the articular eminence exhibits its greatest anatomic concavity. Hence, a protrusive record about 5-7 mm ahead of CR position gives the most clinically relevant values for condylar guidance.

In this manner, semi-adjustable articulators with adjustable condylar paths allow us the flexibility of fabricating cases at a pre-set value when indicated, while also allowing us to customize the guidance path as and when necessary.

H value cannot be increased without surgical intervention. Hence, the goal of reconstruction is to maintain the current guidance angle, so it does not decrease further with continued parafunction.

The Lateral Condylar Guidance Angle (L)

Synonymous to the horizontal guidance path traced by the condyle during pure protrusion, the lateral condylar guidance angle comes into the picture during side-to-side translation.

Note: L value has 'no role to play towards working side disclusion', as the working condyle does not undergo much translation. Here, the (lateral) anterior guidance angle of the working side plays a dominant role in determining the path taken by posterior teeth during lateral translatory movements. Thus, canine guided occlusion or group function can be designed for a patient irrespective of L value settings.

However, L value plays 'an extremely crucial role in achieving posterior disclusion on the balancing side'.

Fortunately, this can be easily accomplished on a semi-adjustable articulator, by arbitrarily setting its L value at an angle greater than that anticipated on the patient. Literature states that average skeletal value lies between 7 to 10°. Hence, articulators can be routinely pre-set at a lateral guidance angle of 15° (on both sides), to provide a greater side shift than what is expected anatomically.

If balancing side interferences can be eliminated on the articulator at this value, the excess clearance automatically translates into greater disclusion of the balancing inclines intraorally.

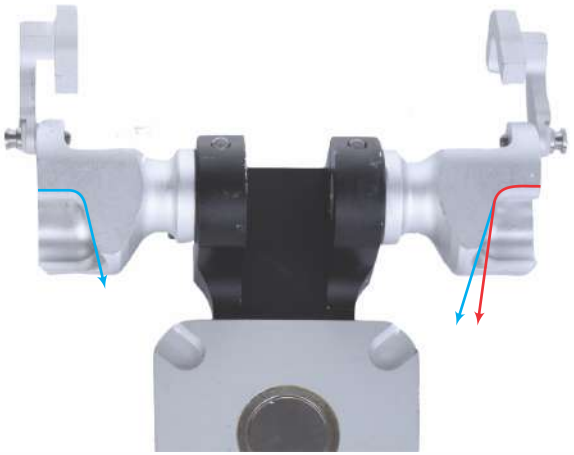

Fig. 8.56: The average progressive side shift (towards midline) is marked in red, while the value set on the articulator is marked in blue. **Note:** To ensure balancing side disclusion, the progressive side shift on the Corident CSA 400 articulator is set at an angle greater than what the patient's condyle is estimated to travel. This guarantees balancing side disclusion, each time the mandible undergoes side-to-side translation.

As simple as this sounds, pre-setting the L value at 15° is extremely effective, practical and has no ill-effects on the final prosthetic design. In fact, this value does not have to be changed for any tooth supported reconstruction, regardless of the complexity of the case. Hence, many articulator companies manufacture articulators that have a pre-fixed (unalterable) progressive side shift angle of 15°. Common sense lies in purchasing such an articulator, as these are easier to use and obviously cheaper.

Fig. 8.57, 8.58: Left: Corident CSA 400 articulator with a pre-fixed L value of 15°, Right: Corident CSA 600 articulator with a customizable L value.

Fig. 8.59: Corident CSA 600 articulator set at varying L values. Although possible, this adjustment is not necessary for tooth supported FMR cases and hence only adds to the complexity of a semi-adjustable articulator.

The only time L value needs to be customized is when fabricating complete dentures with bilateral balanced occlusion. Here, lateral bite records or the 'Hanau formula' is used to precisely quantify the L value for both sides.

Put together, H and L values represent the condylar pathway. On the articulator, they dictate movements of the condylar ball bilaterally and restrict them within the patient's border movements. When all adjustments are made correctly, you can trust that the articulator will move like the patient does, and occlusal adjustments done on the articulator will be replicated in the patient's mouth. This way, no gross intraoral adjustments would be needed, as the hard work of designing and refining the occlusion has already been done on the articulator.

In retrospect, the posterior determinant of occlusion (CG) can only be quantified on the articulator through a protrusive record taken intraorally; while the anterior determinant of occlusion (AG) can only be customized intraorally via editing of temporaries copied from wax-ups designed on the articulator. In other words, the back end of the masticatory system is transferred from the mouth onto the articulator, while the front end of the system is transferred from the articulator into the mouth. This is because anterior guidance and condylar guidance are independent of each other, but function in a combined manner to determine and safeguard the anatomy of posterior teeth.

Is it necessary to have a Bennett side shift adjustment on the articulator?

Immediate side shift involves bodily movement of the mandible in a lateral direction prior to initiation of the orbiting movement of the non-working condyle.

Because CR is the midmost condylar position that is braced by bone, it is physiologically impossible for the condyle to move any further medially (without fracturing the bony articulation). Thus, 'Bennett side shift' or 'Immediate side shift' cannot occur when the condyles are in their CR (midmost) position. As all reconstruction cases are accomplished at the CR position, adjustment for side shift is not needed on the articulator.

Fig. 8.60-8.62: Note the bodily movement of the incisal pin on the incisal table in this Coridient CSA 600 articulator.

In fact, this setting on semi-adjustable articulators can be a cause of huge concern, as it has the capacity to ruin the entire reconstruction. In the scenario, when the setting is changed from 0 to a + value, the upper frame of the articulator will physically translate side-to-side, prior to initiation of lateral excursion. Such an occurrence is detrimental to occlusal anatomy, as it would produce major interferences during dynamic movements. The end result would be unnecessary flattening of all cuspal architecture. Besides, articulators with this unnecessary mechanical addition are more complex to manufacture and thus more expensive.

Fig. 8.63: Coridient CSA 600 articulator with immediate side shift setting at 0 on the right side and + 4 on the left side.

If your current articulator has a mechanical adjustment for immediate side shift, I would strongly urge you to set it at 0 on both sides and glue it there. This would eliminate any possibility of a mishap from accidental incorporation of side shift into the designing of the reconstruction. **Note:** This does not eliminate the progressive side shift from occurring, as the balancing condyle can continue to translate as dictated by the H and L values.

To sum up, enlisted below are set of requirements that should be fulfilled by an articulator that is to be used for tooth supported full mouth reconstructions.

Shared significant features

- ★ Must accept a facebow transfer,
- ★ Must permit casts to be secured with removable mounting plates that are preferably magnet retained,
- ★ Must have a sturdy frame, with preferably metallic articular components that do not wear easily with use,
- ★ Preferably allow mounted casts to be interchanged amongst articulators of the same make (cross-mounting), such that only mountings need to be sent to the laboratory without having to send the entire articulator.

At the back end of the articulator:

- ★ Must have a centric lock or latch to hold the condylar ball at 'home' position,
- ★ Must have an elastic to pull the condyle back to home position following translation,
- ★ Must have condylar paths with adjustable horizontal guidance angle, from 0 to (at least) 45°,
- ★ Must have condylar paths with pre-fixed lateral guidance angle of 15°, or be adjustable from 0 to (at least) 15°,
- ★ Must have an inter-condylar width of approximately 110 mm. Adjustability in this dimension is not a critical factor,
- ★ Must be an arcon type design (fossa element is part of upper frame and condylar ball a part of the mandibular frame),
- ★ Preferably open track, that allows for the upper member to be separated from the lower,
- ★ Preferably designed such that its body can be oriented at an angle for improved labial access,
- ★ Preferably designed with a wide view body for improved lingual/palatal visibility,
- ★ Must not have a setting for immediate side shift.

At the front end of the articulator:

- ★ Must have an adjustable incisal guide pin, with demarcations (in mm) that allow quantifiable changes in vertical dimension,
- ★ Must have a flat incisal table that is removable and changeable.

Note: Once these essential requirements have been fulfilled by a particular articulator, adding more components or settings, is truly unnecessary. Adjunct gears not only add to the complexity and cost of the instrument, but also increase the possibility of incorporating errors, if (in worst case scenario) the articulator gets accidentally set at values that are not physiologic to the human stomatognathic design.

Contrary to popular belief, FMR cases can be successfully constructed on fairly simple articulators. Because all maxillary and mandibular posterior teeth are restored in a FMR case, we have greater control over the occlusal plane and the final cuspal anatomy. This allows us the liberty to even use a fairly basic 'set-path' articulator for those cases where the anterior guidance can provide posterior disclusion.

These are articulators where both the condylar guidance angles (H and L) are pre-fixed at specific values and cannot be changed. Because a 20 to 25° horizontal and 15° lateral path functions perfectly well for achieving posterior disclusion in the majority of patients, most set-path articulators are designed with these values.

Fig. 8.64, 8.65: CSA 300 from Coridient (left) and Hanau Mate from Whip-mix (right), are examples of set-path articulators that accepts a facebow. In the recent past, these articulators have grown in popularity as they are very simple and convenient to use, while also being extremely cost effective.

However, for a set path articulator to be used, it should fulfil all other requirements of a semi-adjustable articulator listed above, the most important of which is accepting a facebow record.

Note: Set-path articulators should not be used for diagnosis or treatment when patients present with occlusal plane problems, gross interferences or compromised anterior guidance, etc. as knowing the precise condylar guidance path becomes an important consideration in these cases.

CONCLUSION

Selection of the an appropriate articulator is a very important decision for every clinician, as it is not just related to practicality and effectiveness, but also subject to one's affordability.

It is common to see uninformed clinicians invest a sizable amount of time deciding upon a make or model, and then landing up erroneously buying the 'more expensive articulator', under the false pretext that it would allow even complex cases to be treated. This is unfortunate, as even fairly simple semi-adjustable (or sometimes set-path) articulators work just fine for full mouth reconstruction cases, as multiple aspects are under the operator's control.

Intelligence lies in customizing the articulator settings for those cases where precision at the back end of the instrument is necessary, and when it is not, the articulator settings can simply be pre-fixed at H=20° and L=15°. There is no justifiable reason to complicate instrumentation beyond the requirements presented in this section.

There are many articulators to choose from. One should always select a system that feels comfortable to use, has a good track record and does not compromise on quality. Remember, most articulators are a 'one time investment' and once you get accustomed to its design and functionality, changing your articulator then may not be a smooth transition.

So buy once, but buy good! CSA 400 variant by Corident is my personal choice in this regard.