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Hinge Axis and Orientation Jaw Relations

Dr. Divya Dahiya[1], Dr. Anita Hooda[2], Dr. J.S Gulia[3]

[1]Professor, Department of Prosthodontics PGIDS Rohtak
[2]Senior Professor, Department of Oral Anatomy, PGIDS Rohtak
[3]Professor, Department of Otolaryngology, PGIMS, Rohtak

INTRODUCTION

Establishing maxillo-mandibular relationships in partially or completely edentulous individuals has engaged the attention of prosthodontists ever since the profession began to understand and interpret the various dynamic and static positions of the condyles in the glenoidfossa.

Two types of movements are known to occur in the TMJ, a hinge like movement taking place between the condyle and the articular disc and a translatory motion between the articular disc and the roof of the glenoidfossa.

Jaw Relation Or Maxillomandibular Relationship**:**Any one of the infinite spatial relationship of the maxilla to the mandible.

Jaw Relation Record: Definition: A registration of any positional relationship of the mandible relative to the maxillae. These records may be made at any vertical horizontal or lateral orientation**(GPT 9)**

Biological consideration
A good prosthodontic treatment is always concerned with providing *OCCLUSION* in complete dentures.

This *OCCLUSION* can only be provided with the thorough knowledge of various factors like :-

- Relationship of mandible to cranium (TMJ)
- Complex movements of mandible
- Tissue resiliency
- Muscle functions

Temporomandibular joint
Point at which mandible is connected to the cranium
TMJ affects the dentures & likewise dentures affect the health & function of TMJ

Unsatisfactory Maxillomandibular relation

- Failure of complete dentures and prosthesis
- Time consuming and costly repairs**.**

CLASSIFICATION
Jaw Relation

- **Orientation Relation**
- **Vertical Jaw Relation**
- **Horizontal Jaw Relation**

Vertical Jaw Relation :

- Vertical Jaw Relation at rest
- Vertical Jaw Relation at occlusion

Horizontal Jaw Relation
Centric Relation
Eccentric Relation : → **Lateral**, **Protrusive**

Mandibular Movements

- Mandible moves about a transverse horizontal axis during opening and closing.
- Mandible also rotates around a saggital axis when one side drops down during lateral excursion.
- Mandibular movement occurs around vertical axis during lateral excursion.

ORIENTATION JAW RELATION

(Reference to Cranium)
The relationship of the maxilla to the cranium in three planes anteroposterior, lateral and vertical is called the orientation jaw relation.

- Relation of Maxilla to Terminal hinge axis in skull must be reproduced in the articulator
- The opening movement to bring the jaw from**occlusal to rest position is almost a pure hinge movement.**

Definition: jaw relations that orient the mandible to the cranium in such a way that, when the mandible is kept in its most posterior unstrained position, the mandible can rotate in a sagittal plane around an imaginary transverse axis passing through or near the condyles. GPT -8

- The axis can be located when the mandible is in its most posterior unstrained position by means of a **Face bow.**
- The opening movement to bring the jaw from occlusal to rest position is almost a pure hinge movement.
- Here the mandible moves on an arc of a circle with a definite radius from the TM J
- This path of the condyle is determined by the curvature of the condylar head and the curvature of glenoidfossa
- Pure rotation of condyles takes place in the first 10-15 degree arc of mandibular opening and closing or during the initial mouth opening of 20-25 mm.
- Later the condyles and disc translates along slopes of articularfossa. This movement is a combination of rotation and translation.

According to Boucher :This is a relationship between the jaws and the axis of movement, not an anatomic relationship between jaws and TMJ, except to the extent that the axis of movement might happen to be near TMJ.

- Since the radius is not constant for all the patients it has to be determined for every individual patient.
- Relation of maxilla to the opening and closing axis has to be determined.
- Opening and closing axis can be located when the mandible is in its most posterior position by means of a *FACE BOW*

Hinge axis (Okeson) :Mandibular movement around the horizontal axis is an opening and closing motion, referred to as Hinge Movement and horizontal axis around which it occurs is therefore referred to as "HINGE AXIS".

- The Hinge movement is the only example of mandibular activity in which a "pure" rotational movement occurs.

Terminal hinge axis(Dawson)
Since rotation of condyles occur when mandible is in its terminal retruded centric relation position, it was known as terminal hinge axis.

Transverse horizontal axis
Today with the changing concept of CR, vizantero-superior bracing, the term transverse horizontal axis is preferred to terminal hinge axis.
(GPT 8):

" It is an imaginary line around which the mandible may rotate within the sagittal plane."
Hinge axis: An imaginary line through the two mandibularcondyles can rotate without translation (HEARTWELL)
Hinge axis points/ Posterior reference points (GPT 8) Two point, located one on each side of the face in the area of the transverse horizontal axis, which, together with an anterior reference point, establish the horizontal reference plane

Synonymns of hinge axis

Horizontal axis,
Intercondylar axis,
Terminal hinge axis.
Transverse axis

Hinge axis is a horizontal axis around which the condyles rotate during opening and closing movement up to a range of

Posselt (1952) 19-25 mm
Ulrich (1896) about 20mm
Campion (1905)10-20 mm
Fischer (1935)20mm and
Hayek (1937) 25-30mm.

Clinical Use Of Terminal Hinge Axis

- The location of the transverse hinge axis serves only to orientate the maxilla and to record the static starting point for functional mandibular movements. It does not record centric relation or condylar movements.
- Allows the transfer of the opening axis of jaws to the articulator so that occlusion would be on the same arc of closure as in the patients mouth.
- The hinge axis recording is required to check the accuracy of two centric records.
- Helps in proper positioning of the casts in relation to inter condylar shaft.
- Vertical dimension of occlusion can be altered on the articulator

Like centric relation ,hinge axis is

- Stable
- Learnable
- Recordable
- Reproducible and
- Repeatable

Therefore it is used as an important reference in mounting casts in the articulator, so that the opening axis of the articulator coincides with the terminal hinge axis of the patient.

History of Hinge axis

- Gray and his followers recognised that mandible moves on a hinge axis
- Balkwill in 1865 -mandible turns on an axis that runs through both the condyles during opening and closing movement.He mounted the casts such that the angle formed by occlusal plane of teeth and the plane formed by line extending from condyles to incisal line of lower teeth is 22 to 30 deg.
- **Snow (1907):** Recognized the importance of the hinge axis in mandibular movements Developed a face-bow to be used to transfer the position of the axis to the articulator**.**
- **Sicher** :
  The hinge axis, or terminal hinge axis is that position of the mandible from which or in which pure hinge movement of a variably wide range is possible.
  - **Sloane(1951):** "The mandibular axis is not a theoretical assumption, but a definitely demonstrable biomechanical fact.It is the axis upon which the mandible rotates in an opening and closing function when comfortably, not forcibly retruded".
  - Harry Page(1958): Proposed the **transographic *concept.*** Postulated the existence of two mutually independent, noncolinear axes or, simply, that each condyle has its own axis of rotation.

Theories Of Hinge axis

School Of Thoughts Regarding The Transverse Axis (**Aull- 1963)**

1) **Absolute location of hinge axis**.
   - The hinge axis is a component of every masticatory movement and can not be disregarded.
   - If the hinge axis of the articulator is not the same as the hinge axis of the patient then the mechanical reproduction of jaw motions are impossible.
   - Believe that there is a definite transverse axis & should be located accurately.
   - The supporters of this group like Lucia (1960), McCollum (1955). Stuart claims that: with the aid of the face bow it is possible to relate the maxillary cast to the transverse axis of the articulator in the same relationship as the maxillae are related to the anatomic mandibular axis through the condyles.

2) Arbitrary location of hinge axis

Accurate location of THA is of some value , but no added value over arbitary location to be worth the added effort necessary to locate it .

Craddock &Symmons stated that – The search for the axis is troublesome , more of academic interest as It will never be found more than few milimeters distant from the true center of thecondyle**.**

3) Non believers in transverse hinge axis location.

- believe that it is impossible to locate terminal hinge position accurately as this position is theoritical not practical.
- The hinge movement along with the fragmentary movements cannot be repeated by an articulator which is about one axis only.

4) Split axis rotation

This group believes there are two axis of rotation (one in each condyle) and condyles rotate independent of each other. There must be two axes parallel to each other with both axes at right angles to the opening and closing movement of the mandible.

The horizontal axis is a hypothetical line connecting the two horizontal rotation centers of the two condyles of the mandible.

Harry Page -transographic concepts.

- Two mutually independent ,**non collinear** axis i.e each condyle has its own axis of rotation.
- condyle is assymetrical body and **same** vertical, horrizontal and transverse axis of rotation **does not** exist – **so a common point of rotation does not exist.**
- Page first suggested that there are two nonintersecting transverse axes controlling rotation in the sagittal plane.
- He reasoned that since the mandible is asymmetric, the condyles cannot lie in a common plane of orientation. One will be higher, lower, ahead, or behind the other, thus perpetuating the innate irregularity of the mandible.
- Furthermore, since the condyles are gross irregular objects and not spheres, according to mechanical axiom they cannot rotate on point centers but must instead rotate on line centers. There is condylar asymmetry leading to two transverse hinge axis one for each condyle.
- Two independent hinge axis would require the translating condyle to change its vertical height, when this condyle serves as the hinge axis the opposite condyle will translate with a change in vertical height.

METHOD OF ORIENTATION

Establishing the plane of orientation:

ARBITRARY METHOD OF ORIENTING THE CAST

- The casts are centered anteroposteriorly& laterally between upper & lower articulator members
- Occlusal plane is positioned to a determined average value which is marked on the articulator
- In Hanau articulator level of occlusal plane is marked by a groove in incisal pin
- This makes occlusal plane about 3.5mm below a horizontal plane passing through the intercondylar shafts (which is Balkwill's average value position)
- In this orientation individual variations are not taken into consideration

Face bow

The face bow is a caliper like device that is used to record the relationship of the jaws to the temporomandibular joints or the opening axis of the jaws and to orient the casts in the same relationship to the opening axis of the articulator. (Boucher)

Uses

- Records spatial relationship of maxilla to cranium by help of some anatomical refrence plane.
- Transfer this relation to articulator - facebow transfer.

Importance of facebow transfer

- Determines terminal hinge position
- Duplication of all arcs of closure on the instrument.
- Cusps can be tailored to harmonize with these arcs

- Weinberg et al- 5 mm deviation from hinge axis leads to antero-posterior displacement error of 0.2mm in second molar region.
- Casts mounted in dynamic relation as in patients mouth

Advantages of facebow

- Permits more accurate use of lateral rotation points for arrangement of teeth
- Aids in securing anteroposterior cast position with relation to the condyles of mandible
- Registers horizontal relationship of casts quite accurately thus assisting in correct location of incisal plane
- Aids in vertical positioning of casts on the articulator
    - (JPD 1959)

- Control of vertical dimension on articulator , without disturbing the centric relation
- If here are subsequent changes in VDO , an occlusion restored to incorrect arc of closure will have deflective contacts , causing damage to periodontal ligament, TMJ pain damage to edentulous tissues
- Helps to secure a centrcinterocclusal record by **fixing the anteroposterior relation of mandible to the shape of articular eminence**. CR is restricted to purely rotational movement about the transverse horrizontal axis.
- Enables to determine if patients CO is in harmony with CR
- Hinge axis records the **static starting point of functional mandibular movement**
- Makes it possible to duplicate all eccentric relations and all possible contact of teeth in these relations

Types

1) **Arbitrary Face Bow OR Empirical Bow**
    - **Fascia Type**
    - **Ear Piece type**

eg: Fascia-H2 seriesEarpiece- hanau spring bow, denarslidematic , whipmixfacebow, twril bow

2) **Kinematic Face bow OR Hinge Bow**

Types of Arbitrary Face Bow

- use approx. points on face as posterior points of refrence.
- locates hinge axis approx within 5mm of true hinge axis. Suffices in complete denture as minor errors in hinge axis may produce minor occlusaldiscrepancy which are corrected by minor adjustment.

Facia type –

Posterior reference point is 13mm anterior to EAM
Anterior point of reference is orbitale
Hanau (H2 articulator series

Earpiece type –

First described **by *Dalbey***in 1914 but gained popularity in 1960's
Posterior reference point is EAM
Anterior point of reference is orbitale

- This is based on the fact that external auditory meatus has a fixed refrence in relation to hinge axis , and special condylar compensations on face bow or articulator compensates by positioning condylar inserts at a prescribed distance behind rotational axis on articulator.

Eg: Haanu spring bow, Denarslidematic, Whipmixfacebow, Twirl bow

Ear piece type are more popular as

- Simple to use
- Does not require measurements or marks on face
- Teteruck and Lundeen show it to have more accuracy than arbitary mark on ala-tragus line

Kinematic face bow/ hinge bow/ adjustable axis face bow

- Locates hinge axis exactly and transfers to articulator
- More complex instrument, requires fabrication of clutches , to be attached to lower jaw (avoided for CD, as it causes more dis-placability due to weight besides resiliency shifting the record base thus hampering accurate hinge axis location)

- Requires fully adjustable articulators with condylar shafts which must be extended to meet stylus of face bow(if stylus is extended, true hinge axis is lost.

KINEMATIC Vs ARBITRARY FACE – BOW

	KINEMATIC	ARBITRARY
1.	Opening axis is located physiologically	Axis is located using anatomic landmarks
2.	Rotational points located by attaching to mandible as patient opens & closes his mouth . A pointer is adjusted until axis of rotation is located	Centers of rotation are located 13mm anterior to EAM on lines towards outer canthus of eye.
3.	Used in F.P.D & full mouth rehabilitation	Used in fabrication of complete dentures
4.	Requires elaborate equipment & is time consuming	Not as complicated as kinematic
5.	Locates the true hinge axis with exceptional accuracy	Locates the rods within 5mm of true hinge axis

SPRING BOW

- It is an earpiece face bow
- made of spring steel and simply springs
- open and close to various head widths.
- This instrument is designed to orient the occlusal plane to the Frankfort horizontal plane by means for a **third point of reference**

Advantage :

- Easy and efficient to use.
- The one piece design of bow eliminates the moving parts and maintenance problems encountered with other models.
- Sterilazable parts.
- Adaptability to other articulation.

Disadvantage :

- Inability to measure intercondylar distance

METHOODS OF LOCATING HINGE AXIS

- Arbitrary methods
- Kinematic methods

Arbitrary methods

--by skin surface landmarks, **as shown by Beck to be closest to THA** (of which Bergstrom point is the closest, followed by Beyron , and least closest is Gysi.

Dejoyuexpoint : 10-11 mm anterior to ear on line to canthus and 5mm below it

Lauritzenboundner axis: 12mm anteroir and 2mm below portion of FH plane

Bergstrom point : 10mm anterior to center of spherical insert for external auditory meatus and 7mm below FH plane.

Gysi point: This was on a line from the upper margin of the external auditory meatus to the outer canthus of the eye, 13 mm in front of the anterior margin of the meatus .

Beryon point: 13mm anterior to posterior border of center of tragus on a line joining outer canthus of eye.

a) Schallhorn , Swenson, Craddok and Symmons
b) Lauritzen, bodner, Weinberg
c)) Teteruck and Lundeen :It is located 13 mm anterior to the tragus on a line from the base of the tragus to the outer canthus of the eye.

Abdal- Hadi point-based on the corelation b/w facial width profile of face (measuured from ectocanthion to centre of EAM) and X – co-ordinate (anteroposterior coordinate of kinematic point).

Y=9.5+0.95 (X)

Superio-inferior -0.5mm superior to line passing from centre of EAM till outer canthus

Anterior reference points

Orbitale-lowest point on inferior orbital rim

Located by- **palpation** of overlying skin with a ball burnisheror **Salzmannmethod**; described a point on lower margin of orbit which is directly below the pupil when patient looks straight ahead

Ref plane – axis –orbital plane

Drawback of using this palne- **lowers the maxillary cast anteriorly** from a position that would be if FH plane is used

Advantage- simple to locate and easy to teach and understand

Orbitale minus 7mm-

Reference plane –**Frankfortshorrizontal plane**

FH plane is parallel to floor when an individual is in upright position

It is more logical to orient maxillary casts to this plane , so that the articulator would represent the patient more accurately

Problem in choosing FH planemost**articulators donot have porion** as cranial landmark **Gonzales and Kingery - "axis – orbital" was lower than the FH by 7.1mm.**

Compensation was done as mentioned below in order to use FH as plane of ref. even in articulators without provision of porion landmark transfer

Mark orbital pointer of**face bow 7mm below orbitale of patient.**

Position orbital pointer **7 mm above the orbital indicator on the articulator**

Payne and Ortman – uses **infraorbital foramen as landmark**

Bergstrom's arcon articulator automatically compensates for this by placing orbital indicator 7mm above the condylar axis

Alternatives to using infraorbital pointer – incisalrefrence notch on incisal guide pin

A-axis –orbital plane , approx 54 mm above max incisal edges

B & C-FH and orbital minus 7 (modified axis orbital plane)-i.e. 54-7mm or 47mm above max incisal edges

D- Hanau incisalrefrence notch – 30mm above maxillary incisal edges

Nasion minus 23mm- the cross bar of quick mount face bow at level of orbitale

Ref plane – axis orbital plane

Sicher recommends another skull landmark – nasion, corresponding to deepest part of midline depression , below level of eyebrows)

Located by nasion guide / positioner (in quick mount face bow used with whipmix articulator)

The nasion guide can be moved in and out, not up and down from its attachment to facebow crossbar

Position of cross bar is

23mm below midpoint of the nasionpositioner at level of orbitale

so when face bow is positioned anteriorly by nasionpositioner, the ***cross bar is in approximate region of orbitale***

During transfer to articulator, the ***cross bar supports the upper frame of articulator and its inferior surface in plane with articulator hinge axis.***

So it is the cross bar of quick mount face bow that is anterior point of refrence, not the nasion.

Drawback is that technique depends on-

nasion guide

Morphological characterstics of nasion notch

Variance of nasion -23 = orbitale in diff patients

Ala of nose

Ausburgerstated :occlusal plane should be parallel to Camper's line)line joininig ala of nose – most rounded eminence on lateral surface of nose till centre of tragus).

Snow also recommended to make occlusal plane parallel to camper / Bromellplane , that is parallel to maxillary and mandibular bows of articulator

Gysi and Kohler used a similar plane c/as "**prosthetic plane**"

2 methods to relate tentative or actual occlusal plane parallel to the horizontal plane are

Transfering campers line from patient to articulator

Marking left or right ala of nose

Set anterior reference point to ala

Transferring the ala anteriorly and hinge points posteriorly from patient to articulators hinge – orbital plane indicator

Dawson palpatory method

- Operator is behind patient
- Index fingre is placed over joint area
- Patient is asked to open wide
- As condyles translate forward , the fingre tip will dip into a depression where condyles were
- When the patient closes, condyles translate back into position , so felt by fingre tips
- Axis is usually near centre of depression felt by fingre tip And is within 2 mm of true hinge axis

Kinematic mehod

- Most accurate method as developed by Mc Collum in 1921.- by trial and error method
- Technique is same for both dentulous and edentulous but methods of attatching the cluth to mandible are different

Clutch for dentulous

Stock metal clutches attatched to teeth with quick setting stone or plaster

2 piece , custom cast metal clutch attatched to teeth with zinc oxide eugenol impression paste

Special clutches made with cold cure resin with help of clutch formers

Clutches for edentulous

- Compound occlusal rims are attatched to self cure / processed acrylic resin record base
- Specially designed bite fork is secured to the rims with its stem extending forward paarllel to saggital plane
- The assembly is attatched to mandible with chin clamps or chin straps
- Attach cross bar to clutch and side arms with stylus to cross bar
- Guide mandible to terminal hinge closure
- Observe the movements of stylus. When stylus rotates without arching movements indicates hinge axis point
- At terminal hinge closure stylus should make contact on skin to transfer ink mark.
- The two marks are hinge axis points

Instruments

Buhnerberg instrument

Pantograph

Transograph

Electronic mathematical method

Stereognathography

Axitron-computerised axiograph

Digital recording system

Instruments

Buhnergraph instrument (1970)-Long etal

Used the geometric principal.

• Buhnergraph instrument consists of a U-shaped piece of aluminum

• Attached to the underside of the lower member of a Whip Mix articulator. On each side is attached an adjustable arm containing a pointed shaft which moves in and out.

Pantograph

An apparatus consisting of 2 face bows- one fixed to maxilla and other to mandible
One holds writing device , other holds recording tables
Total- 6 records / writings are made at 3 locations
Three appilances available are
Stuart and Grangers
condylar writers in lower and record tables in upper members.
advantage-visualisation of condylar movement is immediate.
Horrizontal pen is set to terminal hinge axis
Disadvanage-Tedious clutch preparation technique

Guichet-

All 3 writers are in upper bow and, pneumaticallly controlled by 1 button.
Advantage-The apparatus can be easily and speedily used by 1 man.
Disadvantage- horrizontal pen is anterior to terminal hinge axis
Transograph- 1952
Essentially a hinge axis face bow, modified to serve as an articulator
"writing of jaw movements carried to an articulator"
Theory of transographics was postulated by – Berley Mc Collumand Gnathological Society in collaboration with HL Page and Albinson.

Basis of the theory- split axis theory

Condyle is assymetrical body
So its saggital, transverse and vertical axis donot intersect at a common point of rotation

Advantages

Registering device becomes part of articulator , in which hinge axis , Bennet movement, and cranial plane of each individual are incorporated.

Individual **functional movements** incorporated **without the need of any transfer-** thus eliminating any discrepancy common to most of the articulators.

Patients intercondylar=articulators intercondylar distance
Each axial centre is independent of the other- it has no mechanical connection (solid axis) b/w the condylar bearings as seen in mechanical articulators.
The condylar bearings are joined only by means of maxillary and mandibular arches

Axiotron– a computerised radiograph to determine THA
Electromathematical methods-
3 dimensional coordinates for min translatory /Steady point / rotatory point
Precise- due to mathemeatical approach
Stereognathography-
Joint axis can be located with 0.6mm accuracy
Moire Fringe method
This determines whether joint is a simple hinge , or whether joint moves about a changing axis of rotation refered to as locus or centrode
Axis transfer

Clinical value of hinge axis

- Allows for correct recording of CR and its transfer to the articulator
- Starting point of lateral movements
- Permits a change in vertical dimension
- Helps in diagnosis and treatment planning

Variables affecting hinge axis

- Patient variables affecting the T.H.A.
  - **Locations**Condyle
  - **Asymmetry**: condyle are assymetric bodies , positioned assymetrically in cranium and to one another

- Inability to locate a true hinge axis
- **Myospasm or joint pathosis**
- Emotional conditions of patient
- **Mobility of skin:** this is overcome by attatchment of flags or cards close to skin. However it varies with relaxation of skin – affected even by hair styling

- Factors of the recording system affecting THA
  - Right angle non-right angle system of the bow
  - Length of stylus arms and sharpness of styli

Controversy

There has been a considerable debate about whether:

- A hinge axis exists
- Hinge axis can be accurately located
- One or more hinge axis
- Is it clinically useful to locate the axis
- An arbitrary point can be satisfactorily substituted for a kinematic axis Summary & Conclusion

- A minimal error of 5 mm can be expected no matter what arbitrary position might be chosen.
- Placement of the tragus-canthus line at the superior border of the tragus of the ear will contribute to greater inaccuracy in most patients.
- The largest percentage of true axis locations will be inferior to the tragus-canthus line at the superior border of the tragus of the ear
- Orientation relation enable duplication of arc of closure of mandible and spatial positining of maxilla in relation to the centre of this arc on the articulator.

REFERENCES

[1]. Jeffery P. Okeson. Management of temporomandibular disorders and occlusion, 5th edition
[2]. Zarbbolender-prosthodontic treatment for edentulous patients-12th edition
[3]. Terminal hinge movement of the mandible J Prosthet Dent 1957;7:787-97.
[4]. Winstanley, R. B. The hinge-axis: A review of the literature. J Oral Rehabil 12:135-159, 1985.
[5]. Hinge axis overview ;ashusharmaint journal of clinical dentistry Vol 5, no, 3 : 2012.
[6]. Singh S, rehan S, palaskarj, mittalS.Hinge axis - location, clinical use and controversies. J res dentistry 2017, 4(6):158-161.