



HINGE AXIS - LOCATION, CLINICAL USE AND CONTROVERSIES

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ABSTRACT

The hinge axis is an imaginary line around which the condyles can rotate without translation. Terminal hinge position is the most retruded hinge position and it is significant because it is a learnable, repeatable and recordable position that coincides with the position of centric relation. There are many schools of thought regarding hinge axis. The proponents of Gnathology say that there is one transverse hinge axis common to both condyles which can be accurately located. The proponents of transographics claim that each condyle has a different transverse hinge axis and that a transograph is the only instrument that can duplicate this. Still others claim that an exact duplication of jaw movement is not possible on any machine. The aim of this article is to throw light on location, clinical use and controversies of hinge axis.

KEYWORDS: articulator, hinge axis, centric relation, condyle, split axis

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INTRODUCTION

The TMJ¹ is described as a diarthrodial ginglymus joint. It is capable of two types of basic movements; sliding (diarthrodial) and hinge (ginglymus). The upper articular surface² is formed by the following parts of the temporal bone (a) articular eminence (b) anterior part of mandibular fossa.

The inferior articular surface is formed by the head of the mandible. The articular surfaces are covered with fibrocartilage. The joint cavity is divided into upper and lower parts by an intra articular disc. The upper compartment permits gliding

movements and the lower rotatory as well as gliding movements.

The hinge axis is an imaginary line around which the condyles can rotate without translation. According to G.P.T-8³ the term used for hinge axis is "Transverse horizontal axis which is defined as an imaginary line around which the mandible may rotate within the sagittal plane. Terminal hinge position⁴ is the most retruded hinge position. Movement from this position, a conditioned response, is always less than the median full mouth opening.

The terminal hinge position is significant because it is a learnable, repeatable and recordable position that

coincides with the position of centric relation. The limits of hinge movement in this position have been determined to be about 12 degrees to 15 degrees from maximum intercuspation or about 19 to 20 mm at the incisal edges. The condyles are in a definite position in the fossae during the terminal hinge movements.

The assumption that a single terminal hinge axis rotational point exists was agreed upon by Kornfeld (1955), Aull (1963), Sloane (1952), Thompson (1954), Granger (1952). However, doubts were raised by others as to whether or not a single terminal hinge axis exists or not. Kurth and Feinstein (1951) concluded that more than one

point may serve as hinge points. Beck (1959) Trapozzano and Lazzari (1967) concluded that the presence of multiple hinge axis has been established⁵.

LITERATURE REVIEW

Description of the transverse hinge axis

Any three dimensional object that moves in a coordinated rotational path of motion which is a part of a circle or ellipse has a axis of rotation (hinge axis). If the path of the motion of the object is a part of a circle, the axis of rotation itself is not moving. Clinically the patient would be described as a closing on a hinge which is usually a trained motion used for recording purposes. If the path of motion of the object is a part of ellipse, the transverse hinge axis itself must move. Clinically the condyles would be translating as the patient opened the jaw. The path of motion of either type of movement must be perpendicular to transverse hinge axis.

Location of the transverse hinge axis

Geometric location of transverse hinge axis: the transverse hinge axis can be located geometrically by erecting perpendiculars that bisects two or more secants of circular paths. The transverse hinge axis is always perpendicular to the arm of rotation and vice-versa. The transverse hinge axis usually passes through or near the condyles.

Clinical location of transverse hinge axis: a clutch and assembly which has two adjustable pins near the condyles is attached to mandibular teeth. The patient opens and closes in trained (unstrained) rotational path of motion and when this path of motion is part of a circle (if the condyles do not translate),

the pins of the assembly can be adjusted so that they only rotates. This locates transverse hinge axis.

Clinical use of the transverse hinge axis

The terminal hinge axis plus one other anterior point serves to locate the maxillae in space.

Three separate points, or one hinge axis and an anterior point, are required to orientate any solid object in space.

Thus the transverse hinge axis serves to:

Records the static starting point for functional mandibular movements and Orient the maxillae

Hinge axis and centrix relation

Mandibular musculature of edentulous patient loses its precise guiding signals (loss of periodontal proprioceptors) in the closing movements of the jaw. A new and precise pattern of proprioceptive stimuli is established by teaching the patient to move the mandible to most posterior position.

This new proprioceptive stimuli established through the TMJ then guides the mandible into a repeatable border position. This biologic phenomena is carried out when a record of centric relations is made. It is assumed that anteroposterior relation of mandible to maxilla at terminal hinge position is same as centric relation.

Method of true hinge axis location

The Lauritzen Research Group at the University of Oregon dental school developed a technique and armamentarium to locate the hinge axis easily and accurately.

A special tray is used to secure attachment to the mandible of the hinge axis locator. This tray consists of an anterior part of rim lock tray. A stem is soldered to it anteriorly and superiorly. The tray is secured to the mandible with alginate impression material. The light weight hinge axis locator is attached to the stem which projects from the tray. A 1 cm² piece of millimeter graph paper is attached to the skin in the region anterior to the tragus of the ear. The needle of the hinge axis locator is moved close to the graph paper, but not in contact with it. With the thumb on the point of the chin, the dentist guides the mandible to open and close in the terminal hinge relation.

The needle will be seen to describe a segment of a circle close to the graph paper. The needle is then moved towards the centre of the circle until the needle does not move in an arch but merely rotates. This is verified under magnification. Thus, the hinge axis point has been located.

Since the skin in the area is readily moveable and influenced by the position of the head rest, all patients are positioned erect in the chair with no headrest support while this point is marked. The graph paper is carefully removed. The mandible is placed in the terminal hinge relation. The locator needle is retracted from its proximity to the skin. Marking material is placed upon the tip of the needle, and the needle is carefully brought into contact with the relaxed skin. Thus an accurate marking is obtained. The process is repeated on the opposite side of the face.

Location of hinge axis by average anatomic measurements

Arbitrary Hinge Axis: the location of hinge axis can be

approximated when arbitrary type of face bow is used. The two posterior points of reference that form the hinge axis are located by measuring prescribed distances from skin surface landmarks.

λ Bergstrom's point - A point 11 mm anterior to the centre of a spherical insert for the auditory meatus and 7 mm below the Frankfort horizontal plane.

λ Beyron's point - A point 13 mm anterior to the posterior margin of tragus of the ear on a line from centre of the tragus to the outer canthus of eye.

λ Gysi point -10mm anterior to posterior margin of tragus on a line from centre of tragus to outer canthus of eye.

λ Teteruck and Lundeens point- 13mm anterior of tragus on line joining base of tragus to outer canthus of eye.

Schallohorn (1957)¹⁰ recommended adjusting face bow pins to a point 13 mm anterior to tragus on tragus canthus line and found that in over 95% of the subjects with normal jaw relationships, the kinematic centre lies within a radius of 5 mm from the arbitrary centre. According to Weinberg -11 to 13 mm anterior on a reference line drawn from middle and posterior border of tragus of the ear to the corner of eye.

Single and split transverse axis

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

Clinical evaluation of the error produced

According to Weinberg (1959), the anatomic transverse hinge axis location and the subsequent face bow transfer within a 5 mm error is a practical and dependable method for orientating the maxillary cast. Inter-occlusal centric relation records that limit the inter-occlusal opening to 6 mm at the incisors produce a negligible error (0.1044 mm at the incisors). The anatomic face bow hinge axis location should be within 5 mm of the actual transverse hinge axis of the patient. The gross error that is produced clinically is not due to the hinge axis location or mounting but to the centric relation record itself.

Controversies

Much literature has been published on the transverse hinge axis and the schools of thought about its relation to articulators. The proponents of Gnathology, say that there is one transverse hinge axis common to both condyles which can be so accurately located as to justify their permanent tattooing.

The proponents of transographics claim that each condyle has a different transverse hinge axis and that a transograph is the only instrument that can duplicate this.

Still others claim that an exact duplication of jaw movement is not possible on any machine and that it would be better to use an articulator, such as the Hanau, that utilizes a face bow mounting and an average of several readings for excursive movements. The different schools of thought regarding the transverse hinge axis has led to the evolving of four main groups: Group I - absolute location of axis; Group II - arbitrary location of axis; Group III - non believers in transverse axis location; Group IV - split axis rotation.

Group I - Absolute location of axis: these are those who believe that there is a definite transverse axis and it should be located as accurately as possible. The proponents 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. The path of closure on the terminal hinge will therefore be the same on the articulator as in the mouth. The critics of this theory claim that most of the articulators are designed on the assumption that the transverse hinge axis is an imaginary line connecting a point in the centre of one condyle with a point in the centre of the opposite condyle. The gnathoscope, gnatholator, Hanau, House, Dentatus, Terrell, Stuart and Bergstrom Arcon all have one intercondylar shaft.

However, these optimum conditions do not exist in the mandibular apparatus, which is asymmetrical in shape and size. The condyloid processes are joined at the symphysis with no connection between the condyles. And also the condyles do not lie in a common plane of orientation. The assumption of

a single intercondylar transverse axis is therefore, open to serious question.

Group II - Arbitrary location of axis: the second group favors the arbitrary location of axis and subscribes to the view that determination of the true hinge axis is not essential when one looks at the effort required to find it. Hinge axis may be determined by simple palpation or by following the convention of measuring a distance of about 10 mm anteriorly along a line drawn from the upper free margin of the tragus to the corner of the eye.

The critics of this group claim that group II fails to recognize that if the hinge axis of the articulator does not coincide with the hinge axis of the patient the path of closure will not be the same.

Group III - Non believers in the transverse axis location. This group believes that it is impossible to locate the transverse hinge axis with accuracy. Believes the transverse axis is theoretical, but not practical. Bohr and Posselt could not record the axis on a modified Hanau H articulator without errors. Errors mounted to 1-1.5 at 10-15 degree opening. Beck states that opening and closing hinge movement of the mandible, together with its fragmentary movements, cannot be repeated by the opening and closing movements of an articulator which is about one axis only. Therefore, an arbitrary terminal hinge position would or could be just as accurate as one located with a Kinematic face bow.

Traozzano and Lazzari found that in 57.2% of the subjects in their investigation, more than one condylar hinge axis point was located on either one or both sides of the face.

The critics of this group claim that the main motion is pure rotation plus slight translatory movements, the

composite of which adds up to a common centre of rotation. Since this performance is repeatable, it becomes a reliable point of orientation.

Group IV - Split axis rotation. Group IV includes those who follow the transograph theory. They believe in the 'Split axis' with which each condyle rotates independently of the other. As the mandible is not bilaterally symmetrical and the terminal hinge position mark on one side of the face is usually a little higher than it is on the other, it would follow that there cannot be a common axis. There must be two axis parallel to each other with both axes at right angle to the opening and closing movements of the mandible. The condyles are irregular and hence to not have a single point of rotation.

Frank in roentgenographic studies of condylar positions reported that no one condyle was found to be placed symmetrically in relation to its opponent.

CONCLUSIONS

A theoretic and clinical discussion of the transverse hinge axis has been attempted in relation to some of the controversial concepts. In the final analysis, the true value of our individual work can be measured only by the degree of fineness with which we practice the art of dentistry rather than by the particular school of thought to which we adhere.

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