

THE TEMPOROMANDIBULAR JOINT

Its Anatomy and Physiology in Relation to the Design of Ortho-Tain[®] Prefomed Positioners and Appliances

A brief discussion of the anatomy and physiology of the temporomandibular joint (TMJ) is important since this knowledge has been an integral part in the specific design of the original prefomed positioner and other prefomed appliances by this author.* Since the mandible is movable in relation to the maxilla, it becomes quite critical how a device can be made that engages the teeth in occlusion for any specific patient, let alone for a group of patients. Complicating this problem is the controversy regarding the "normal physiologic" position of the mandible in relation to the maxilla at both rest and in occlusion. On one side of this controversy is the "hinge-axis" theory where the mandible is placed in a "retruded position" in relation to the maxilla while the other view is where the mandible is allowed a "more forward position" in its closure into the occlusal position with the maxilla. Which is correct?

The hinge-axis was popularized in the fabrication of full dentures since it was a fairly repeatable position, a dependable starting point of jaw relation, and could be duplicated with a fair degree of accuracy. There is a tendency for edentulous people to protrude the mandible during closure, particularly during overclosure. When dentures were made, they often were fabricated in an over-protruded position in occlusion. The hinge-axis, by its very nature, established a repeatable position of closure and soon became very useful in prosthetics as a result. The next step was to adapt the technique to individuals with a full or partial dentition for reconstruction. The technique, however, ignores most anatomical and physiological considerations of the joint and is, in fact, diametrically contrary to most of these considerations¹⁻⁴.

(a) For example, the TMJ is the most versatile and complicated of all joints in the body, having both hinge and translatory movements, either separately or at the same time. All other joints of the body have a freedom of excursion beyond the normal resting position as a "hedge" against displacement and overmovement. To accept the hinge-axis by definition as "the most retruded", or "the most comfortably retruded position", denies this safety movement. It would not be physiological for the most versatile of all joints to have this freedom of excursion

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in every direction but the one that this artificial definition has denied. Most individuals that have never had any clinical symptoms of TMJ problems have a retrusive movement from the occlusal position of from 1 to 2 mm without pain. By definition (according to hinge-axis proponents) all of these individuals would possess "anterior displacements" that should be corrected to a more retruded position of the mandible by equilibration, reconstruction, orthodontic treatment, or surgery. Most clinical problems become abnormal when they extend beyond the limits of two standard deviations of variability and yet the hinge-axis philosophy would be recommending treatment to most clinically normal patients that would, as a result of this treatment, have no variation in the retruded direction. Does it seem logical to also be treating orthodontic cases to this same stringent retrusive requirement?

(b) Most patients that have clicking or crepitus or pain of the temporomandibular joints almost always have it at some point during the opening and sometimes during the closing cycle. Anatomists feel this clicking is due to the articular disc slipping or snapping over the anterior margin of the condyle in opening, almost always making a clicking sound. On closing, the condyle slips off of the posterior edge of the disc as the mandible is moved backward away from the disc. The slipping of the disc up onto the condyle and then back off the condyle is probably

caused by a stretching or tearing of the support of the articular capsular ligaments, allowing the lower half of the joint to "subluxate" where the articular disc slips past the condyle, while in healthy joints they are held together as one in all movements of the mandible. The clicking on opening and closure can, in most cases, be eliminated by having the patient open and close in a slightly forward position (of e.g. 1 to 2 mm forward). As a matter of fact, one of the most successful techniques of eliminating TMJ pain and clicking is to place a splint between the posterior teeth to advance and open the mandible slightly, which prevents the patient from overclosing^{3,4}. This unhealthy overclosure, without the splint in place, forces the mandible upward and backward and encourages the mandible to move posteriorly while the disc is pulled anteriorly which then slips off the condyle often producing a closing click. At times if the disc "squishes" forward off the disc without snapping off, there will be no closing click. Almost always, however, there is an opening click when the mandible slips up over the disc as the mandible slides down the eminentia. The splint enables the patient to function in a newly established occlusal position, which is downward and forward with almost universal and immediate elimination of all pain. In fact, upon each removal of the splint, immediate return of the click and/or pain is experienced. This common splint therapy is successful in about 80% of joint cases⁵.

A similar problem often results in orthodontic retention when the vertical overbite is allowed to relapse while the returning overjet is prevented from relapsing. The result is often accompanied with TMJ clicking or pain caused by a significant overbite with little or no horizontal overjet. This forces the mandible to assume a postero-superior abnormal position or displacement and causes subluxation of the lower half of the TMJ. The most commonly used Hawley retainer generally allows about 30% relapse of the overbite and fortunately usually also allows the overjet to relapse a similar amount. However if the overjet is prevented from relapsing while the overbite increases, a potential TMJ problem is possible. Custom made positioners allow a relapse of the overbite since all the teeth are set up to occlude ideally at the same time, but unfortunately this same custom positioner allows all of the teeth (anterior and posterior) to be equally depressed which encourages the overbite to relapse as the overjet is being restricted from relapsing. As a result this combination of overbite collapse and overjet maintenance is most detrimental in causing joint problems. The *original preformed positioner* was purposely designed to prevent this problem by providing extra material in the anterior segment and less material in the posterior segment while at the same time advancing the mandible downward and forward almost to an end-to-end incisal position.* In this way, there are no depressive forces placed against posterior teeth and it encourages the corrected overbite to be retained while the overjet is held in its corrected state. Statistics have indicated that no more than 6.5% mean relapse of the overbite beyond normality occurs as long as the child wears the Ortho-Tain® positioner at least partially during waking hours.⁶ For the same reason, it is a mistake to make a positioner, either custom or preformed, to try and reflect the true free-way space since depressive forces are placed on posterior teeth as well as anterior teeth, which thereby causes a relapse in the orthodontically corrected overbite while effectively holding the overjet. It has been shown that about 46.6% relapse in the corrected overbite occurs within 2½ months of wear of a custom positioner when it is made to reflect the true free-way space or over seven times greater than the preformed positioners by Ortho-Tain®.⁶ This significant relapse in overbite is occurring at the same time the overjet is essentially being retained with little or no relapse.

What does a hinge-axis positioner accomplish? Unless the material that exists between the teeth as rubber or plastic exceeds the normal free-way opening, it really does not accomplish anything since the opening through the free-way space is pure hinge anyway. However, when the mandible is positioned posteriorly from its normal relation with the maxilla, the mandible is forced distally and is capable of causing pain while the positioner is in place. A hinge axis positioner would tend not to retain a corrected overjet well, since the mandible is set distal to its normal position with the maxilla. The three-dimensional wedge-shape to the free-way space is quite variable between individuals and is difficult to duplicate exactly even with the most carefully constructed custom positioner using an articulator. It is quite easy to create premature contact of the posterior teeth if the positioner free-way space does not match the patient's exactly.

This is the second reason for accentuating the anterior opening of the preformed positioner to eliminate the chance for these prematurities. As a result, there are fewer than 3% TMJ symptoms with the use of Ortho-Tain® preformed positioners because prematurities are prevented from occurring except in the most extreme long-face syndrome (dolicocephalic), high angle cases. It is for this reason that positioners should not be used in excessively high-angle cases that exceed 2 S.D. or about 39°.

When this same Ortho-Tain® preformed positioner is used in patients that have recurrent TMJ symptoms, these symptoms disappear as the overbite is reduced with daytime exercise. At the beginning these symptoms usually recur when the positioner is withdrawn, but as the overbite is corrected, the clicking and pain permanently subside provided the patient is growing. In an adult, the symptoms disappear as long as the patient wears the preformed appliance at least once per week while sleeping. These appliances, however, are not recommended for “closed lock” TMJ patients at least until the disc has been recaptured and held for at least three months while ligaments healing takes place.

The hinge axis positioner fabricated from a machine registration taken from the patient allowing lateral and protrusive excursions of the teeth prior to fabrication, in theory, one would normally think has merit. Several problems however do exist, and one of these is that the positioner will not prevent rotation relapses of any teeth other than the upper and lower incisors. Teeth with "round" circumferences have little or no retention or movement by the positioner. The second problem is that torque is also not possible with a positioner since it is usually incapable of moving teeth other than by tipping motion. Even arch width retention is impossible with a positioner unless it can be worn 24 hours each day. If such precision movement is required for tooth position, it would be necessary at the present time, to provide these movements before the appliances are removed. Other methods of holding the teeth exactly in these precise positions would have to be provided. The positioner, whether custom or preformed, because of its rubbery nature and the fact that it can be worn actively only a few hours out of each 24 hour period, would not be the retention of choice if such precision were required. This author would seriously question whether such precision is actually an advantage to the patient, particularly in view of the questioned reliability of the machine to actually duplicate human jaw movements coupled with the highly questionable "physiology of the hinge axis technique".

(c) Anatomically, the human disc of the TMJ is avascular in the thinned center and the fibrous tissue of the articulation is also avascular and this tissue is present only on the articular eminence of the temporal bone. It does not continue posteriorly into the fossa, therefore, it would seem obvious that this tissue is not adapted for frequent retrusive movements. Also, the disc is fused with its fibrous capsule on only the lateral and anterior margins while the posterior margin has considerable loose connective tissue innervated by numerous blood vessels and nerves unadapted to retrusive movements as proposed by hinge-axis followers. Some justify a posterior jaw position when opening the jaw on a hinge axis, because they reason, the chimpanzee can posterialize it's mandible. In the adult human, unlike the chimp, however, there is little space posterior to the ramus of the mandible to allow for such hinge opening of the mandible. This area is filled with parotid tissue as well as many blood vessels and nerves and is also confined by the mastoid process and the downward bend of the posterior cranial base. Pure hinge opening beyond the rest position without translation or sliding is accompanied by pain in the human, thereby necessitating translatory opening in an anterior direction, combined with a hinge opening to prevent constriction of this area posterior to the ascending ramus. The chimp, on the other hand, has no such constriction and functions well with a full pure hinge opening.

(d) Muscular attachments also preclude retrusive movements in that the upper head of the external pterygoid is attached to both the disc (articular capsule) and the neck of the mandible anteriorly so that any anterior pull normally will move the disc and condyle in unison. Posteriorly, the situation is much different in that the deep fibers of the masseter and the posterior

fibers of the temporalis muscle are attached only to the mandible. Forced retraction of the mandible or forced hinged opening which can be trained, places unequal forces on the condyle and disc which would tend to sublunate or separate the tightly attached disc from the condyle by unequal forces pulling the condyle posteriorly, while the disc unopposed by any retrusive muscular fiber attachments is pulled anteriorly. For these above reasons, it would appear that a forced hinge position could cause joint problems.

REVIEW:

Due to the above physiological and anatomical facts completely unopposed by the hinge-axis proponents tip the scale to a more anterior position of the mandible in relation to the maxilla. Some hinge-axis proponents recommend creating an overbite without overjet to insure a stabilized retruded hinge position. This is the creation of a treatment philosophy to satisfy a subjective claim. When a treatment philosophy does not adhere to human physiological principles, it is time to seriously question the original premise. This is not a new battle for it has been fought for fifty years and why the sudden surge in orthodontics for a renewed application of the hinge-axis philosophy is difficult to understand. A highly recommended video film showing a conscious patient's functioning temporomandibular articulation with clicking sounds is a most convincing indictment against the hinge-axis philosophy⁷. The original Ortho-Tain® preformed positioner was designed to satisfy these physiologic and anatomic principles discussed above and will continue to defend these principles adopted in its design.

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