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Short Communications

TEMPERO-MANDIBULAR JOINT: THE KINETICS OF ELEVATION & DEPRESSION

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Abstract:
The temperomandibular joint (TMJ) is a multiaxial ginlymoarthrodial synovial joint endowed with a capacity to perform a wide range of movements , primarily through its bicondylar mandibule freely articulating with a stationary (fixed) fossa of the squamous temporal. This short paper elaborates on an odd, yet possible, movement that can be performed by the joint: An illusory and paradoxical 'depression' that can result by a reversal in the roles of the two articulating bones, the mandible and the temporal. Whereas in classical depression, the TMJ utilizes two axises, the same joint during performance of the reversed articulation uses just a single axis to achieve an identical final outcome, separation of the alveolar ridges of two bones.
This paper here discusses the kinetics and articular dynamics that coordinate the plethora of performed or possible movements with special reference and a closer observation of the depression – elevation sequence.
Keywords : Temperomandibular joint, hinge, bicondylar, illusory depression, axis

Introduction

One of the most active and complex joints, is thetemperomandibular. The TMJ is one among the only two synovial joints endowed with an articular disc (the other being the sternoclavicular. Classical descriptions of the movements possible at the joint, usually describe it as a multiaxial, synovial and gynglimoartrodial. Orthodontist and prosthodontists, however have debated off and on, often disagreeing on the type the joint is classified as: Is it a condylar or a hinge, or both?

The mandible, for one, is one of the few bones to ossify in membrane (covering the cartilage of the 1st. arch) and for another, it is characteristic in that it possesses features that lineate it under in three distinct and different classifications in arthrology – the two halves of the mandible unite through a symphisial joint (secondary cartilaginous), its two rami, along with the temporal ,form bilateral condylar synovial joints and its alveolar process houses a tandem of tooth-socket gomphosial (fibrous joints). The joint exhibits a wide range of movements, the bicondylar parts of the mandibular rami articulating with the temporal fossae: the oddity of the intervening cartilagenous disc, divides the joint cavity in an upper and lower compartment, each half performing its role in enabling complex movements of the mobile mandible as mandated in mastication.

This brief communication takes a fresh approach to understanding the kinetics (1) and presents yet another view of the dynamics of the elevation-depression movement at the TMJ

Discussion

Classical teaching and texts on TMJ functional anatomy and movements, describe the involved processes in definitive and isolated terms: elevation - depression, protraction - retraction and rotation. The upward, downward, forward, backward and side-to-side excursions of the mandible require a wide range of action between the condylar head of the mandibular ramus and the temporal fossa. The spin, rotation, roll, pivot and glide of the mobile condylar element using both, the upper and lower units of the articular disc divided joint cavity produce all known movements of the bone. While the antero- posterior (horizontal) axial movement produces

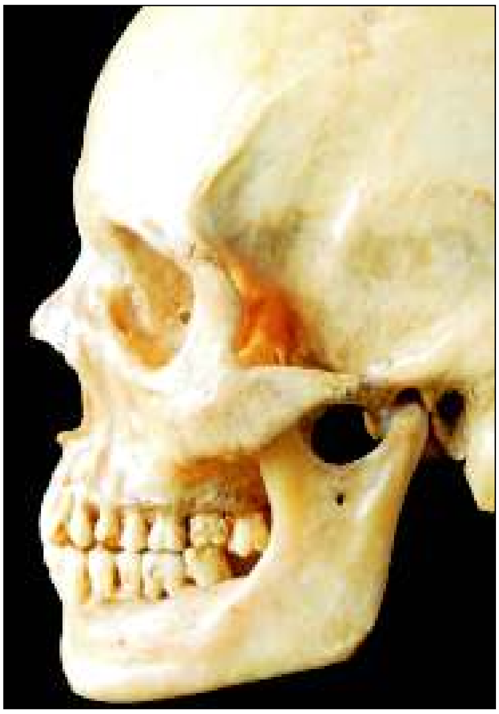

Figure 1: Norma Lateralis

Figure 2: Complete depression of mandible involving two levels of transverse axises (a) across the condyle and (b) across the ramus through the mandibular foramen

Figure 3: Paradoxical 'depression' of mandible caused by elevation of maxilla involving only a single transverse axis passing across the condyle

protraction and retraction is a glide / slide (Figure), side-to-side (chewing) movements are produced by alternating asynchronous movements of each half of the mandible. One dominant half of the mandible pivoting anticlockwise or clockwise through its head, the axis being vertical passing through the temporal fossa and condyle (rotator) and the other half essaying a similar, but passive sortie (orbiter) – the vertical axis, marginally shifting to the left or right or vice versa in the rotator half and their translation in the non-dominant orbital half.

Mastication, a dynamic and continuous process using all axises , is primarily and exclusively performed by the mandible's alveolar process abutting, grinding, gliding or sliding on, against and across the alveolar ridge of a static maxilla.

Mandibular depression and elevation though, are however not as simple as appear – for these hinge (2) movements the transverse axis passes through the mandibular foramens and not the condylar heads as is often assumed. While for a transient initial phase of depression, the head rotates as a hinge with the transverse axis passing through the two condyles (3), a greater part of depression is produced by an imaginary hinge located at the ramus of the mandible, with a fresh transverse axis passing through the level of the mandibular foramen (Fig: 1, 2 & 3). In essence the head, first rotates and then glides forwards and downwards (4). The transverse axises for depression passing along hinges (one conventional and the other a fulcrum) at two locales and levels (5) (Fig 3 A).

Kinetics and dynamics of motion permit yet another hitherto unexplored movement in the temporomandibular joint. Though seemingly impossible and logic defying, the TMJ can be activated to move the base skull and maxilla upward and downward on a fixed and stationary mandible. To elaborate, despite the loss of mechanical advantage (as postulated under the 'principles of levers' in physics), extension at the cervical joints (neck extension) if generated powerfully enough through extreme action (contraction) of the muscles of the neck, extensors of the suboccipetal triangle and extensors such as erector spinae (iliocostalis cervicis, longissimus cervicis, spinalis cervicis, splenius capitis, semispinalis capitis, sternocleidomastoid and trapezius and the extensor spinalis, can and will elevate the maxilla along with the entire skull around a transverse access, to duplicate a reversed depression of the mandible – the difference being, instead of the mandible being depressed by its own muscles (lateral pterygoids and geniohyoids, for example), the maxilla is elevated by action of the cervical (neck) extensors. The role of the digastrics is worth a second look into. While the anterior belly aids mandible depression, the posterior belly helps in neck extension, creating a illusory depression through maxillary elevation. This 'paradoxical' opening of the mouth (by elevating the maxilla instead of depressing the mandible), by definition, coverts the temperomandibular joint to an illusory but functional 'mandibulotemporal 'joint. (Fig: 4, 5 & 6)

Though paradoxical action of muscles is known to mycologists (6), the biomechanics and physics of 'reverse' articulations is an unexplored commodity. Though the human anatomy permits, and all of us do perform many reverse movements without being conscious of them (to example -one can flex the thigh and raise the knee while standing, by using femoral flexors origination from the hip bone complex through acetabulo-femoral (hip) joint, but one can also mimic femoral flexion by flexing one's back (as in bending forwards to pick up something from the floor from a standing position). In the latter movement, even though the femoral flexors are inactive, the recti of the anterior abdominal wall bring the axial skeleton to forwards and downwards – producing in effect a femoral flexion in which no hip or femoral muscle involves. The oddity of the reversed articular mechanics however has an overriding dictum: whether performed, as designed to, by skeletal biomechanisms or 'engineered' to perform through remote leverages and non-antagonistic muscle groups – the final results are similar in either and by using the very same axises of movement through the reference parent joint.

The TMJ is perhaps one of the few, if not the only cranial joint that can be maneuvered to reverse movement by a functional inversion in the active -passive roles of the condyle of the mandible and the temporal fossa. Moreover, far more peculiarly, the temperomandibular joint when reversing to the mandibulotemporal , solely utilizes the transverse axis passing through the mandible's condylar head , moving clockwise to raise the skull base and maxilla and totally exempting the transverse axis passing through the two rami (the axis used in normal depression – elevation). Though the final results, vis-à-vis the positions of the mandible and maxilla, whether one is depressed or the other is elevated, are seemingly similar – the locales of the axises used are dissimilar: whereas in mandibular depression, the axis passes transversely through the mandibular foramen of the ramus and the bone rotates around it; in elevation of the maxilla the transverse axis passes through the condlylar head. In effect, despite the juxta-positioned status of the two articular surfaces being identical, in the first case it is achieved by a forward and downward glide of the head brought about by rotation along the transverse axis through the ramus and in the second it is a backward rotation of the temporal bone brought about by a rotation of entire skull along a transverse axis, passing through the two mandibular condyles. The forward glide of the condyle within the fossa, a characteristic component of mandible depression, is totally absent during maxillary elevation.

Figure 5: Depression of mandible brought about by rotation along two levels of transverse axises

Figure 4: Norma frontalis

Figure 6: Paradoxical depression of mandible through elevation of the maxilla involving a single transverse axis

There is no other joint in the skeleton, save the temperomanibular, which can use two different axises, one, as a classical hinge and the other as a modified fulcrum to engineer one final result - enhancement of the gap between the alveolar ridges of the upper and lower jaws

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