FUNCTIONAL ANATOMY OF THE TEMPORO-MANDIBULAR JOINT (II)

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FUNCTIONAL ANATOMY OF THE TEMPORO-MANDIBULAR JOINT (II) (Abstract): Jaw movement is analyzed as an action between two rigid components jointed together in a particular way, the movable mandible against the stabilized cranium. Opening and closing movements are symmetrical; that is, both sides of the cranio-mandibular articulation are making the same movements. Protrusive and retrusive movements may also be symmetrical. The mandibular muscles determine all the complicated postures and movements of the jaw. Their behavior can be greatly clarified by restating certain fundamentals crucial to purposive muscular activity. The joint derives its arterial supply from the superficial temporal artery and the maxillary artery. Branches of the auriculo-temporal and masseteric nerves and post-ganglionic sympathetic nerves supply the tissues associated with the capsular ligament and the looser posterior bilaminar extension of the disc. **Keywords:** TEMPORO-MANDIBULAR JOINT, JAW MUSCLES, POSTURES, MOVEMENTS, MANDIBLE.

Physicists point out that the most general type of motion a body can undergo is a combination of translation and rotation (1). Translation is defined as a motion in which all points of a rigid body move in the same direction with the same velocity, at any given instant, relative to the same point outside the body. Rotation is a motion in which some points of a rigid body move in one direction while other points move in the opposite direction, at any given instant.

Now it can be readily seen that a partially lowered mandible can translate, that is, more forward or backward over the articular eminence with all points of the jaw moving in the same direction at the same rate, at any given instant. Thus in simple lowering and rising of the mandible, the definitive statement must be that the condyle rotates relative to the disc while the disc is rotating relative to the articular eminence with concurrent translation of the mandible relative to the temporal articular faces. It is simply a problem of relative motion, and mandibular movements are completely consistent with the general observations in the physics of motion (2).

MOVEMENTS

Opening and closing movements are symmetrical; that is, both sides of the cranio-mandibular articulation are making the same movements. Protrusive and retrusive movements may also be symmetrical. In this case disc and condyles of both sides slide downward and forward and backward
and upward, respectively, with condyles and discs always, as in all joints of the body, in firm contact with their opposing articular surfaces. Movements may also be executed asymmetrically, which then produces a lateral movement, a swinging of the jaw to one side. In this case one disc, accompanied by its condyle, slides downward, forward, and medially on to the preglenoid and medial glenoid planes.

The disc and condyle on the side to which the jaw is moving (left condyle for left lateral movement) do not travel far from their starting positions on the posterior or slope of the eminence. Here the condyle orbits very slightly downward then outward in a small arc around a vertical axis somewhere behind the condyle. This imparts a transverse component to the excursion and thus produces a direct lateral shift of the entire mandible to the chewing side. This has been called the Bennett movement, or Bennett shift, and although it may be slight (probably never more than 1.5 mm) it has been considered significant in certain cases of restorative and prosthetic dentistry (2).

The lower joints of both sides work together as a common hinge joint. The two discs are the sockets, or „hooks”, of the hinges, and each condyle forms the bar in the eye of the hinge on which the jaws swings open and closed. Because of the notable obliquity of the condyles to the frontal plane - the condylar axes converge posteriorly - the hinge movement of the mandible must be accompanied by adjusting movements between condyles and discs. The hinge movement occurs around a horizontal axe that runs approximately through the centers of the two condyles. Thus, during opening, the lateral pole of each condyle, situated in front of the hinge axis, must move slightly downward and backward. Concomitantly, the medial poles, situated behind the hinge axis, must move slightly upward and forward.

This information is highly significant clinically in radiographic interpretation. Ignorance of these anatomic facts has resulted in the belief that condyle and eminence does lose contact (separate) during normal jaw movements, since a dense lateral pole is seen radiographically to move away from the eminence. But, as pointed out previously, areas of articular contact are constantly shifting during movement in all joints of the body; thus contact is shifting toward the medial pole in simple opening. This prevents concentration of pressure at any point for any length of time (3). The broad areas of the close-packed position are adapted to withstand the peak of functional pressure.

Under normal conditions, sliding in the upper joints and rotating in the lower joints are probably always combined, but the magnitude of one or the other at a given time varies considerably. Both mandibular joints, always working together as a functional unit, can be classified as a hinge joint with a sliding socket (4). This definition clarifies the proper role or functional significance of the articular discs; they comprise the movable sockets of the hinge joint between the condyles and discs. The combination of two joints on the each side of the jaw gives a certain freedom of movement to the mandible in all planes of the space. But the fact that the articulating components always work in close contact obviously imposes some limitation of movement because of the two-sided articulation. Furthermore, the magnitude of these movements in not great, since they are effective limited by all the various fibers of the temporo-mandibular ligaments of each
side in the opened positions, to which is added the contact of the tooth plates in terminal closing positions.

**RANGE OF MOVEMENTS**

Beginning with the condyles retruded to the extreme hinge position, the mandible can perform a theoretically pure hinge rotation about a fixed axis passing through the approximate centers of both condyles. In opening, the interdental point swings down in an even arc of about 20 to 25 mm in length. Further opening requires a downward and forward excursion of condyles and discs along the articular eminences, with continued rotation of the condyles within the lower joint compartments. This activity within the joint abruptly changes the course of the incisal point. It then proceeds in an arc of greater curvature directed more anteriorly, in which the lower termination marks the limit of greatest jaw opening.

From this point closing proceeds directly upward and forward with the mandible strained forward in maximal protrusion during its entire path of movement. The interdental point now describes an arc of the least curvature in the sequence. Its upper termination is brought about by contact of the posterior teeth, since the lower anteriors reach forward beyond the upper anteriors with the jaw in its most protruded position. In making this movement, the condyles rotate backward in the lower compartments, and both condyles and discs move slightly posteriorly. From this point the circuit of extreme movement is completed by retrusion to the original point of departure at the most retruded hinge position of the jaw. The path is necessarily uneven because of the shifting contacts of the teeth. Proceeding form the most protruded contact position, where the lower incisors are anterior to the uppers, the path of the incisal point dips to the edge-to-edge contact of the incisors, rises to the position of complete occlusal interdigitation, then dips again as cusps are cleared to reach back to the terminal hinge position.

Movements in the transverse, or horizontal, plane can be similarly traced. Again beginning with the mandible in its most retruded (terminal hinge) position, the jaw is rotated to one side as far it will go with teeth just touching. In doing so it turns around a vertical axis somewhere behind the condyle on the side of the movement. If this is the left condyle it moves little, orbiting laterally in a small arc with a short radius of curvature. The condyle of the controlateral side, however, orbits in a long flat arc, since its radius of curvature is much longer. Thus the right condyle slides downward, forward, and inward to the anterior limit of the articular plane. This movement of the jaw carries the incisal point laterally and forward in a mild curve to the right. From this position the jaw is swung toward the midline in full protrusion. Thus the right condyle now slides downward, forward and inward to the interior limit of its articular plane. This movement carries the incisal point forward and medially in a mild curve to the same point of greatest protrusion visualized in the sagittal view (5).

The reverse action is now carried out by moving the jaw to the extreme of the left lateral excursion, the left lateral condyle thus moves up and back toward the most retruded position. Finally, the right condyle follows till mandible is returned to the original point of departure in the most retruded hinge position. The outline traced by the incisal point in this total excursion is
diamond-shaped, and it defines the marginal movements of the jaw in the horizontal (occlusal) plane. When these lateral movements are made with the jaw at increasing levels of opening, the diamonds become smaller and smaller until they disappear at the point of maximal opening identical with that visualized in sagittal view.

MUSCLES AND THE MOVEMENTS IN THE TEMPORO-MANDIBULAR JOINT

The mandibular muscles determine all the complicated postures and movements of the jaw. Their behavior can be greatly clarified by restating certain fundamentals crucial to purposive muscular activity. In the first place, there are three distinct roles that a muscle can play when activated: it can contract isotonically and shorten to act as a mover of a part; it can contract (tense) isotonically yet lengthen to act as a balancer for a moving part; and it can contract isometrically, hence neither shorten nor lengthen, to act as a stabilizer of a movable part. In the second place, surprisingly large groups of distant muscles must act in the seemingly simplest functional movements.

When a jaw muscle contracts in the absence of a restraint, the mandible is pulled in the direction of the shortening muscle. The muscles have therefore been classified as protruders (lateral and medial pterygoids); retractors (posterior fibers of temporalis assisted by digastric and geniohyoid); elevators (anterior and middle fibres of temporalis, superficial and deep fibers of masseter and medial pterygoid); depressors (lateral pterygoids aided by digastric, geniohyoid and mylohyoid); lateral movers (medial and lateral pterygoids of each side).

All these muscles are active in all mandibular movements - some as movers, some as balancers, and some as stabilizers - shifting their role in accord with the progress of the movement. In close coordination with the above actions, muscles of the neck steady the cranium and hyoid bone to establish stable bases from which opening and closing muscles can pull (6). Since precise movements of the tongue are an integral part of masticatory activity, the hyoid bone is seen to move in rhythm with the jaw in chewing. It shifts continuously with firm stability to differing positions of mechanical advantage both for jaw opening and bolus manipulation.

Movements are described beginning from the centric occlusal posture with all teeth in even contact. In this position the elevators of the jaw are under active contraction, whereas in the rest position these muscles are safe to be in tonic contraction. There are two major movement sequences of the mandible in which some teeth come into contact: a cutting movement, such as that used by incisors and canines to bite off a piece of food, and a grinding movement, such as that used by molars and premolars to comminute a piece of food.

Both masticatory movement complexes - cutting and grinding - can be analyzed in three phases. The first, the opening or preparatory, phase is a free movement of the jaw. The second phase begins with the beginning closing action and ends at the approach of contact. The third phase is a truly articulatory movement. It occurs with the contact of teeth. The first phase requires little force. Considerable force may be applied during the second and third phases as these phases fuse to produce the masticatory stroke. Furthermore, in actual chewing true contact of teeth probably occurs rarely before many masticatory strokes have been made, depending on the
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resistance of the food.

VASCULAR SUPPLY
The joint derives its arterial supply from the superficial temporal artery laterally and the maxillary artery medially. Veins drain the anterior aspect of the joint and associated tissues into the plexus surrounding lateral pterygoid, and posteriorly they drain into the vascular region that separates the two laminae of the bilaminar region of the disc (1).

In sagittal sections, the disc appears to possess a thin intermediate zone and thickened anterior and posterior bands, and its upper surface appears concavo-convex where it fits against the convex articular eminence and the concavity of the articular fossa. Posteriorly the disc is attached to a region of loose vascular and nervous tissue, which splits in two laminae, the bilaminar region. The upper lamina, composed of fibroelastic tissue, is attached to the squamo-tympanic fissure, and the lower lamina, composed of fibrous non-elastic tissue, is attached to the back of the condyle. The bilaminar region contains a venous plexus (1, 6, 7). Lymphatic drain deeply to the upper cervical lymph nodes is surrounding the internal jugular vein.

INNERVATIONS
The articular tissues and the dense part of the articular disc have no nerve supply. Branches of the auriculo-temporal and masseteric nerves and postganglionic sympathetic nerves supply the tissues associated with the capsular ligament and the losser posterior bilaminar extension of the disc. The temporo-mandibular joint capsule, lateral ligament and retroarticular tissue contain mechanoreceptors and nociceptors.

REFERENCES