Editorial

The View From The Condyle

The study of functional movements of the mandible in relation to the rest of the dentofacial complex is a leading candidate for dentistry's own Tower of Babel, even challenging orthodontics for the doubtful honor. Part of the problem lies in the complexities of the structures and their movements, and part in the mixed vocabulary involving such diverse disciplines as dentistry, mechanics and mathematics.

Even some of the simpler terms do not always mean the same thing to all of us. The endless controversy that surrounds the axis of mandibular rotation is a prime example, but just sorting out the terminology can resolve many of the differences. The key words are *rotation, center, axis* and *translation.*

Rotation is a familiar word for a movement in which all parts of a rotating body follow circular paths around a common center or axis. If a rotating movement continues through 360°, each point will return to its starting position.

Center and *axis* are not quite synonymous terms, and it helps to recognize the differences betwween them.

A *center* is a *point,* located equidistant from the perimeter of a circle or sphere or some other form or object.

An *axis* is a *line,* around which rotation can or does take place. It is oriented in three dimensions, lying perpendicular to the plane of rotation. Axis is an action term, related to rotational movement rather than a physical object.

The axis of rotation of a spinning circle will pass through its center, so the axis and center may appear to be the same when viewed in two dimensions. In an asymmetrical three-dimensional object like the mandible, rotating through only a small arc, all similarity disappears. *Axis* is the correct term in mandibular rotation.

Translation is movement of a body *without rotation.* Translation is responsible for much of the confusion in mandibular function, largely because it is not always clearly sorted out from concurrent rotation. While translation excludes rotation by definition, this does not mean that they cannot occur simultaneously.

Mandibular movement is almost always a combination of simultaneous rotation and translation. What we then see is a resultant "rotation" around a displaced axis. It is not usually a true rotation, because the axis tends to move. The resultant axis is an important phenomenon, but it is only the beginning of the story. Its value lies in derived information, rather than in its own independent qualities.

The displacement of a resultant axis is caused by translation, and it holds the key to identifying that important component of mandibular

movement. Condyle translation is a factor in most TMJ and occlusal dysfunction problems.

The first step in evaluating translation is to identify and clearly define a reference axis for the concurrent rotation. This is essential to separation of rotation and translation. It is an arbitrary decision; axes within a rotating body are legion, and any one can be used as a reference axis.

The underlying principle is that the rotation of a body is the same around *any* axis perpendicular to the plane of rotation. This is where confusion often arises in dental applications, with the introduction of such terms as *true axis*. The problem is understanding, not truth.

A nondental analogy can help visualize the situation. A carrousel obviously rotates around a central axis, but the rotation of a passenger is more complex. Stand next to an outside horse and watch the landscape, and it becomes clear that an otherwise motionless passenger makes one full revolution for each revolution of the carrousel. Move to an inside horse and repeat the ride, and the result will be the same, with only one exception; the simultaneous translatory movement will follow a smaller circular course.

Note that translation need not be linear; it is any movement of an object through space. Translation of a rotating body is fully described by the translation of the axis of rotation, with the movement of individual points dependent on the interaction of the translation and rotation.

For descriptive or analytic purposes we could select an axis of rotation in the passenger, the carrousel, the earth, solar system or galaxy. All are equally valid, but they are obviously not equally relevant. The most relevant axis in this case would be one within the body of the passenger, which enables us to isolate the rotation of the body from the circular translation around the center of the carrousel.

That approach can be equally useful in the mandible. Since translatory movements will be expressed as movements of the reference axis, it can be selected to provide information about the translatory movements of the condyle.

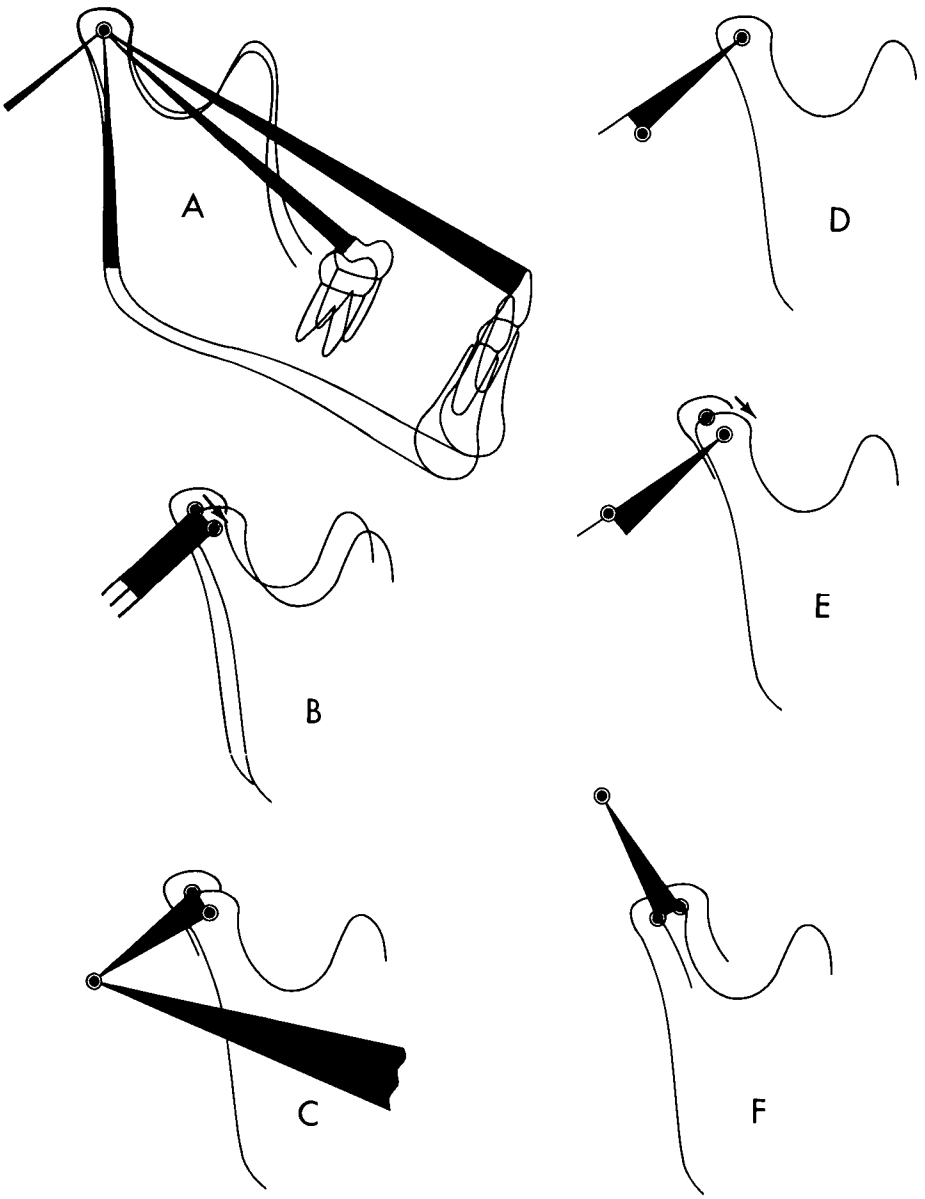
The shape of the condyle head and the configuration of the disk and capsule clearly point to rotation around an axis through the condyles, and to translation of the condyle-disk assemblage. This makes the condylar axis a logical arbitrary reference for measuring mandibular movements.

The questions of "truth" or "correctness" are not relevant, since rotation is the same around any axis. Some other axis could just as well be selected, recognizing that translation would then be related to that axis.

Viewed from the condyle, the mandible rotates around an axis passing through the condyles. Illustration A shows a pure rotating movement around the condyle axis between rest and closure. Every part of the mandible rotates through an equal segment of a circle. Even a line projected outside of the mandible rotates through an equal angular displacement.

There is a hinge axis. The question should not be whether or not a condylar "hinge" axis exists, but rather how that axis may move in function. That requires an understanding of the translatory component of the movement.

The condyle enjoys great translatory freedom at any level of opening beyond occlusal contact. Posture and



other factors easily influence condyle position, as can be instantly demonstrated by simply opening one's mouth. Whether or not we detect translatory movement often depends on the sensitivity of measurement.

In the extreme situation of pure translation of the condyle without mandibular rotation, the axis would lie at an infinite distance (B). In effect, there would be no axis without rotation.

In the real world we can expect both rotation and translation to occur together. The resultant axis that depends on their interaction will be located somewhere between the condyle axis and infinity. Its distance from the condyle axis will depend on relative amounts of translation and rotation.

In C we see what is perceived as a resultant axis of rotation behind the ramus. The rotation is magnified for illustration purposes to approximate 2 cm mandibular opening, but in the course of a 4 mm movement between rest and closure, this displacement of the axis would be produced by only 1 mm of condyle translation.

In D we see the rotation in C, based on a condyle axis. There is movement (translation) in the region of the resultant axis, which is obviously incompatible with an axis at that point. The condyle axis must move as shown in E. In D and E we have isolated the mandibular rotation and translation that are merged together in C.

The translation of the condyle could occur uniformly, or it could all occur at one end of the movement. The resultant axis only tells us that it occurred sometime; it cannot tell us when. The movements are too fine for clinical radiographic or mechanical methods to detect exactly when this translation actually occurs.

A resultant axis located away from the condyle axis not only tells us that there has been translation of the condyle; it also shows the direction of the condyle movement. The resultant axis always lies on a perpendicular to the path of translation.

If the resultant axis is above and behind the condyle, as reported on page 64 in this issue, the condyle movement will be that shown in F. Similar interpretations also apply to the movements shown on pages 65 and 66, and to the Class II, division 2 findings on page 49.

A major problem is assessing mandibular movements is our obsession with precision. It is relevance, not precision that establishes the value of diagnostic information. The very variability of the resultant axis is clinically relevant because it reflects actual variability in condyle behavior.

The resultant axis is a transient phenomenon, constantly in motion. What we perceive as the axis is nothing more than a derivation from two reference points, with at least one of them usually moving.

The view from the condyle need not be the only one considered, but it can add much to any evaluation involving the vital mobility of the mandible.

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