CROWN AND BRIDGE ARTICULATION ON THE TRANSOGRAPH

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IT IS GENERALLY ACCEPTED by conscientious dental practitioners that the oral mechanism be treated as a single functioning organ. The interdependence of all the dental structures precludes the possibility of successful restoration unless the treatment plan encompasses the effect of the prescribed treatment in relation to the complete oral mechanism. Of primary concern are the problems of articulation. The recognition of the degree to which occlusal problems contribute to the breakdown of the normal functional pattern has fostered the development of new approaches in the study of occlusal relations. It is no longer accepted practice to depend on the adaptive capacity of the chewing apparatus to compensate for inadequate methods of articulating teeth.

The men who initiated the research in this field realized that unless they could achieve a fundamental concept of the functional movements of the jaw and develop instruments capable of reproducing these movements, their proficiency would be greatly limited. Certainly, an instrument that would aid us in reproducing mandibular movements with a degree of accuracy, and which would enable us, figuratively, "to place the patient's head on the laboratory bench"* would be invaluable. Diagnostic evaluation of study casts would then be more valid than utilizing the casts in their static relationships. Restorations could be constructed in the laboratory and placed in the patient's mouth with a minimum of adjustment.

In 1926, McCollum[1] and the Gnathological Society of California presented to dentistry new concepts of articulation. At the same time, this group began to develop instrumentation to enable it to apply the functional aspects of its theories. Since that time, they and their adherents have been continually changing and adding to the original instruments and recording apparatus. Their fundamental theories are the basis for transographics, but the applications are entirely different. In the instruments emanating from the Gnathological Society, a recording device is used which can trace pantographs of mandibular motion. By placing an articulating instrument within the same pantographic tracing and reversing the procedure, the instrument is adjusted in an attempt to follow the pantographic writings. The purpose of this process is to reproduce three-dimensional rotatory movements of the mandible in function. With some other instruments, only the transverse hinge axes recordings are accepted; the other dimensions of movement are either accepted as averages or are arrived at by a system of interocclusal records.

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*R. N. Albinson, personal communication.

For the Transograph, however, the claim is made that by starting with the fundamental transverse axes recordings and properly orienting these to cranial structures, it can duplicate the remainder of the functional movements accurately by the use of mechanical equivalents. The simplicity and ease of adjustment of the Transograph are, in themselves, an endorsement of the instrument. Its fundamental importance to the dental profession is, of course, the accuracy with which the desired result can be achieved.

Unfortunately, clinical results must enter into the evaluation of any biomechanical procedure. Highly capable men in the field of restorative dentistry use variations of many techniques. These dentists would not use these procedures unless they felt that by using them they were able to give their best efforts to their patients.

Essentially, dentistry is concerned with the articulation of teeth. The masticatory apparatus must operate in such fashion as to produce the most efficient function without damage to the teeth, the periodontal structures, or the condylar mechanism.

Transographics is a concept that is helpful to the achievement of this end. Transographics is based upon kinematics, that is, the reproduction and control of preconscious, functional jaw movements.

MASTICATORY MOVEMENTS

The movements of the mandible in the act of mastication are considered to be those involved in preparing the bolus for chewing and those involved in the terminal functional orbit. The preparatory movements are extremely erratic and are of no particular importance because, during this phase of masticatory function, no tooth contacts are made. This phase includes all lateral and protrusive movements. The mandible is moving from protrusive or lateral protrusive positions to so-called centric position. As soon as the bolus has been prepared for trituration, the character of the function changes. There is now a rotary-translational movement of the working condyle and a translational movement of the occlusal surfaces of the mandibular teeth, with the mandible dropping down and back, away from occlusal contact. The closing stroke, with which we are primarily concerned, moves the mandible upward, inward, and forward. In the preparatory motions, both condyles are out of their hinge positions. In the final closure (the terminal functional orbit*), the condyle on the working side is braced in its hinge position on the anterior slope of the mandibular fossa. As the condyle rotates and the mandible translates on the working side, the condyle on the balancing side is being returned to its hinge position in the fossa. As long as the angle of closure is steeper in the transverse plane than the cuspal angulation of the teeth, there will be no contact of teeth until the tips of the cusps contact in the bottoms of the fossae. The cuspal inclines do not come into contact during the terminal functional stroke but act as efficient shearing mechanisms. The cuspal tips are driven through the bolus until final contact or the interposed food particles are no longer compressible or displaceable. All of the force is then directed through the long axes

*Theodore Messermer, personal communication.

of the opposing teeth. During the fleeting moment of maximum muscle contraction, the mandible is supported by the full dentition and by both condyles in their hinge positions.

If this theory of mastication is correct, it could account for many previously unexplained formations of occlusion. As one example, a seemingly jumbled arrangement of natural teeth that exhibits no sign of pathology will, when analyzed from a transographic mounting, be found to have perfect cuspal incline coordination and centric occlusal contact in accord with condylar rotational movements. One set of surfaces of the teeth are occluded when the mandible closes upward, mesially, and protrusively; another set is contacted when it moves from a lateral position into retrusion. It is recognized that teeth can be contacted in lateral and protrusive positions, although this is nonfunctional. It is only essential to provide maximum distribution of contact in these nonfunctional positions in order to prevent the overloading of individual teeth, if the patient should indulge in bruxation.

The Transograph provides the means for carrying out this concept. Admittedly, the needs of the dental profession are such that instruments alone do not solve all its problems of occlusion and articulation. The Transograph is a very useful apparatus in the hands of the men who have included it in their treatment procedures. It is a flexible mechanical monitor which will permit individual patterns of occlusion. By using it intelligently and with a full understanding of the theories it represents, the dentist can develop the desired functional occlusion and articulation.

Even though we are particularly interested in the applications pertaining to the natural dentition, the principles of articulation are the same in any field of dentistry. The instrument is used in the identical manner whether it be in analysis of natural occlusion or in the construction of fixed restorations and complete dentures. The old idea that one type of occlusal anatomy would serve in complete denture construction but another type must be utilized in the treatment of a natural dentition has been proved false.

PRINCIPLES OF TRANSOGRAPHICS

There are certain principles on which transographics is based. It is concerned with four elements: (1) the hinge axes, (2) the cranial plane, (3) the Bennett movement, and (4) the envelope of motion. The methods of locating the transverse hinge axes are common knowledge. These axes are the origins and terminals of all condylar functional movements. When the hinge-bow is in position, the axle rods of the locator are rotating along these axes, which are parallel but not in the same plane anteroposteriorly or superoinferiorly.

A cranial plane must be incorporated in the instrument to insure off-sagittal movements which are accurately correlated to the articulation.

The term "Bennett movement" has many interpretations. Primarily, it is a bodily shift of the entire mandible in any one or all three dimensions. A simple parallel is a crankshaft with bearings that are untrue. In fixed, rigid machinery, this irregularity would result in torque of the shaft until the bearings were worn out. Fortunately, in the temporomandibular joint, the looseness of the capsular

ligaments permits the asymmetry noted in the axes recording to result in a bodily shift of the mandible without pain or destruction. In the Transograph, there is a mechanical equivalent of this movement. This is readily accomplished because the instrument is slightly flexible.

The last movement to be duplicated is the angle in the transverse plane along which the subject's functional pattern travels during final closure. This is done by the use of an adjustable jaw movement guide. This guide makes it possible to reproduce the flattest closure angle of the functional pattern. The angles to which this guide is adjusted are experiential. This action continually shifts the vertical, sagittal, and transverse axial centers (by instrument flexing) into composite positions that are equivalent to the positions they assume in the head as the jaw moves along corresponding paths. The Transograph, having correlated the hinge axes to the cranial plane and the Bennett movement, functions around three-dimensional control centers that are equivalent to the same control centers, or hinge axes, in the head. Its envelope of motion is the same as the patient's envelope of motion; therefore, any functional movement the mandible is capable of making is duplicated on the instrument.

It should be noted that the term "mechanical equivalent" has been used several times. The use of this term has caused many men to doubt the validity of the Transograph. The reproduction of mandibular motion is the important factor, not the method of registration.

In systems where recordings are taken with the teeth in contact, even if contact is established by means of a central bearing point, the mandibular movements recorded are those that occur after functional closure. The movements recorded are away from "centric position," and any adjustments to an articulator made from these recordings assume that the paths of closure from an open to closed position are identical to nonfunctional radial lateral movements. As yet, any of the conventional methods for locating exactly the rotational centers have proved either too cumbersome to be of any practical value to the profession in general or to be so indirect that they predispose to the introduction of errors.

The Transograph and the concepts upon which it is based have been tested in practice by many meticulous operators. Their findings have confirmed the accuracy of the Transograph as an instrument and established the validity of the concept of transographics.

REFERENCE

1. McCollum, B. B.: Diagnosis and the Fabrication and Application of Dental Remedies, Pacific Dental Gazette **34**:744-758, 1926.

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