METHODS OF RECORDING MANDIBULAR MOVEMENTS – A REVIEW

Puneet Mutneja
Reader, Department of Prosthodontics.Teerthanker Mahaveer Dental College & Reserach Centre,Moradabad

Abstract
As mandibular movements reflect the functional morphology of TMJ, the occlusal morphology of each tooth may be functionally related to its antagonist, to the TMJ and to the other components of the stomatognathic system in reasonably precise ways.
Articulator specifications thus can be based on common recognizable elements of jaw movements involved in chewing, swallowing, speech, regardless of various occlusal schemes. This would enable the dentist to prevent or minimize periodontal and temporomandibular disease and consequent tooth loss. A study of mandibular movements is thus essential for a clinician to simulate normal functioning of the masticatory apparatus. With a precise knowledge of these, articulator specifications may be accurately made, which enable the dentist and the laboratory technician to build and test prosthetic appliances in an actual functional relationship as it occurs in the mouth. This article attempts to recapitulate the various methods of recording mandibular movements and transferring them to an articulator which facilitates replication of normal temporomandibular joint and occlusal functioning.
Key Words: Movements,Mandibular,TMJ

Introduction

The masticatory system is an extremely complex unit that is primarily composed of bones, muscles, ligaments and teeth. Movements are regulated by the intricate neurological control of the brain, brainstem and peripheral nervous system.[1]

Many different mandibular movements occur during mastication, speech, swallowing, respiration and facial expression. When parafunctional movements are added, the complexity of mandibular movements is obvious.[1]

Unlike natural teeth, prosthesis is either ankylosed to the bone, rests on the alveolar mucosa or on the supporting teeth. Lateral forces produced during mandibular movements due to the prosthesis can traumatize these supporting structures. Therefore a thorough knowledge of mandibular movements is essential for the Prosthodontist to understand various aspects of occlusion before fabricating the prosthesis.[2,3] Any mandibular movement is the result of interactions of a number of biological factors. These include the anatomy and physiology of temporomandibular joint, contacts of opposing teeth, action of the controlling and moving muscles as directed by neurophysiological activities and rotational axis of the mandible. – A thorough knowledge of these biological factors is a prime requisite for the study of mandibular movements.[4, 5]

Methods of recording mandibular movements and programming of the articulator

1) Pantographs

It is a three dimensional dynamic registration procedure utilized in class IV B type of articulators. The tracings produced by pantographs are called pantograms.[6]

The pantograph is an apparatus consisting of two face bows, one fixed to the maxilla and other to the mandible. One holds the writing devices or styli and the other recording tables. Six styli and recording tables are attached. Two are located adjacent to each condylar area in horizontal and vertical planes. Two additional tracing tables are located in the incisal region of anterior teeth, in the horizontal plane. Mandibular movements then produce pantograms on the tracing tables. The mandibular position and pathways recorded on tracing table are most posterior position of mandible to maxilla from where the right and left border pathways of mandible and the protrusive pathway of mandible are traced. These tracing are then transferred to the articulator in the same relationship in which they exist in patient. [7, 8, 9]

In order to eliminate the time consuming procedure of transferring the tracing to the articulator, Denar developed Pantronic in 1982. The Pantronic is an electronic pantograph which provides a computer printout of numerical condylar measurements. In addition several electronic tracings can be made consequently and condylar measurements compared immediately via the computer printout, whereas with mechanical pantograph individual tracings must be transferred to the articulator before condylar measurement can be recorded and compared.[7, 8,9,10]

There are three appliances available for tracings - one designed by Stuart, one by Granger and the third by Guichet. There are slight differences in the three instruments. The styli in the Guichet are on the upper bow and, are pneumatically controlled by one bottom. Thus the apparatus can be used easily and speedily by one man.[9, 10]

On the other hand, Grangers and Stuart's instruments have the condylar styli on the lower member and the arrow point tracing styli on the upper. All writers or styli have to be retracted by hand but can be managed easily by 2 persons. In addition Stuart and Grangers instrument record the center of rotation for each condyle because their horizontal styli are set to the terminal hinge axis.

Guichet does not consider this necessary, unless the vertical dimensions is to be changed and thus it's horizontal styli is slightly forward of the terminal hinge axis.[7, 8]

After the tracings have been completed, the pantograph is stabilized and then removed from the patient. It serves two important functions: First, it acts as a facebow to transfer the maxillary cast to the articulator in an exact relationship to the condyles; second, it stores all the needed information for adjusting the articulator to the precise condylar movements of the patient (this is accomplished by transferring the pantograph from the patient to the articulator). The articulator is then systematically adjusted until each stylus passes directly over the corresponding tracings that represent the patient's condylar movement. When all six styli pass over their corresponding tracings in all three movements, the articulator is adjusted to duplicate the condylar movements of the patient.[6, 9]

2) Stereographics

This system is presented as an alternative method to a pantographic system as it provides a more simplified means of accurately establishing articulator settings for precise technical work. [11]

Stereographic techniques have been described by a number of authors (House, 1931; Boucher, 1933; Kile, 1955; Irish, 1965. Mensor, 1973; Swanson, 1966, 1979; Wipf, 1979) in order to capture the characteristic border pathways via an intraoral clutch system that allows moulding of the condylar guidance.[12, 13]

The TMJ stereographic system (Swanson. 1966; Mensor. 1973)

It requires the development of intraoral clutches with an adjustable central bearing screw incorporated to provide smooth jaw movements. Four studs embedded in the upper clutch allow intra-oral molding of border movements in soft acrylic added to the lower clutch. These intraoral engravings provide a permanent three dimensional record of guided jaw movements, and are then employed to generate the equivalent condylar characteristics on the TMJ articulator guided by these intraoral engravings.[11,12]

The intercondylar distance on the articulator is adjusted to equal that of the patient and the stereographic intraoral clutch records are fixed to TMJ articulator. The right and left articular fossae are moulded in acrylic resin while allowing the articulator to track the engravings on the intraoral clutches. In this way permanent condylar mouldings are made that incorporate condylar inclination, progressive and immediate side shift at the correct intercondylar distance.[13]

The use of intraoral clutches that require recordings to be made at an increased vertical dimension of occlusion in dental subjects has caused concern regarding the ability of such mouldings to accurately generate condylar fossa contour. However, a number of studies have indicated that increasing the vertical dimension of occlusion does not affect the ability of the clutches to accurately capture border pathways.[13]

The greatest variable is the operator error and this is also the case with extra-oral records (e.g. Pantographs). Once the operator has experience in using this system, it becomes a reliable technique.[11]

Advantages of the stereographic recording system include intraoral records are used to capture the patient's border movement which are readily transferred to the laboratory articulator mounting. Intraoral records may be used to generate condyle-fossa analogues and articulator movements. These analogues become the specific articulator characteristics for each patient, incorporating details of condylar inclination and side shift that are otherwise determined by extra oral tracings. Condylar analogues may be stored as permanent records for each patient. [11, 12]

Disadvantages of the stereographic recording system include operator error may result in inaccurate intraoral records. Errors may also occur when molding TMJ analogues in the laboratory, since the metallic studs incorporated in one intraoral clutch (usually, upper) must maintain intimate contact with the opposing clutch record. It is not possible for the operator to observe the cutting rods, as they are obscured by the clutches whilst they are guided by the gothic arch moulding in the opposing clutch.[11, 13]

3) Axiography

By locating the condylar axis and then precisely tracing the movements of that axis three dimensionally, the movement pattern of each condyle can be analyzed.[14]

A healthy properly aligned condyle disk assembly follows a classic convex pattern that starts at centric relation and travels a non-deviating protrusive path down the eminentia. Any variation from the norms can be interpreted on the basis of possible causes for deviated condylar path.[15]

With axiography, mandibular function can be analyzed in relation to both condylar hinge axis and occlusal relationships. Even the compressibility of the disc can be measured.[14,15]

When axiography is combined with specialized instrumentation, it is possible to relate mounted casts to a condylar treatment position that is predetermined for optimum neuromuscular balance so that adaptive remodeling, realignment or healing of articular components will be encouraged.[15]

Axiographic recording procedure includes the following: [14, 15]

Clutch fixation-. The clutch is filled with impression plaster and seated all the way to the occlusal/incisal surfaces and firmly pressed over the lower teeth until the occlusal surfaces contact the inner surface of the clutch tray.

Analyser bow preparation and placement-. The side arms of the bow are adjusted over the ears and the analyser is fixed by placing the straps on top of the head and around the neck**.** The first reference point is fixed at the level of the infra orbital margin.

Placement of recording arm bow-. Before attaching the recording arm bow to the clutch, the vertical screws are adjusted so that the arms are parallel to the cradles and the horizontal adjustment is calibrated to zero. While the patient presses on the recording arms, the posterior edges of the recording arms are aligned to the posterior border of the recording plates at the level of the tragus. The stylus pin is inserted into the collar with the sharp end towards the patient.

Hinge axis location-. One hand of the operator should be cupped under the patient's chin and the other placed on top of the patient's head. The mandible is then moved up and down in the terminal hinge position. The recording arms are adjusted until the points of the stylus do not arc but remain stationary on the graph paper. The axis point is marked with articulating paper, using the blunt-ended stylus**.**

Recording of movements- The non-recording stylus is replaced with a recording stylus which has a sharp black lead extending about 2 mm. To record the opening movement the patient is asked to open towards maximum and this movement is repeated three times. Following this the protrusive movement is recorded in the same manner starting from the hinge axis point.

Conclusion

A Prosthodontist designs prosthesis to replace the lost teeth. For replacement of missing teeth and restoring function, knowledge of the mandibular movements is essential as it helps in selecting and programming of articulators, understanding the occlusion, treating TMJ disturbances, fabricating dental restorations and arranging artificial teeth.

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Corresponding Author:
Dr. Puneet Mutneja
Reader
Department of Prosthodontics
TMDCRC, Moradabad