The range of functional mandibular movement in bruxists. 4. Discussion and conclusions

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Abstract
Part 4 presents a discussion of the results of the study and compares the differences in mandibular movement between bruxists and non-bruxists following analysis of the tests used.

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Discussion
The tooth tapping task provided useful information in demonstrating some minor differences between non-bruxists and bruxists. Whilst similar characteristics were seen in all planes of the non-bruxist and bruxist mandibular movements, the difference between the two groups was the frequency with which the patterns recurred (for example, both smooth and irregular movements were observed in all planes of each group). However, although it seemed that irregular pathways occurred more frequently in the bruxist group, no method could be found for quantifying this because of the difficulty in defining what was irregular and what was not (as shown in some of the envelopes of motion in Fig. 1, for example). An explanation of the trend to irregularity of pathways in bruxists is not clear, but it might be related to muscle co-ordination, causing continual correctional activity of the subject's muscles of mastication, in an attempt to maintain jaw movement in the desired direction. Where this was seen in the non-bruxist group, the subjects involved may have been 'potential' bruxers, for whom a consistent definitive diagnosis is not possible at present. The difficulty of proving this supposition is related to the impracticality and even the ethics of placing a relatively large number of needle electrodes in all of the muscles of mastication in an electromyographic study. Furthermore, it is not possible to obtain reproducibility precisely by this method. The considerable variation in masticatory movement shown by the broad and narrow envelopes of motion in each plane of both groups is a feature which may have been due to differences in individual anatomy such as those of bony inclinations of the head of the condyle and the glenoid fossa, and the thickness of the interposed meniscus, or the relative dimensions of the cranium and mandible producing varying origin-insertion distances and angulation of muscles and ligaments. Another possible explanation may be variations in muscle tone or muscle activity between individuals. Minor lateral deviations in tapping movements opening from IP were common to both groups. However, large lateral movements were occasionally found in bruxists (not in non-bruxists); perhaps another example of co-ordination problems of the former group. In the sagittal plane of both groups, an early anterior movement or protrusion was observed in some subjects prior to the main opening movement. These early small protrusions may be related to either occlusal characteristics not observed clinically or they may be of muscular origin with some elements of the lateral pterygoid muscles acting fractionally earlier than the suprahyoid muscles.

There also appeared to be no preferred direction of movement to the left or the right of IP in either group, or even from cycle to cycle in some subjects of each group. In the sagittal plane the opening phase was anterior to the closing phase most
commonly in both groups, which is in agreement with the findings of Schweitzer in his photographic studies of mandibular movement with an empty mouth. The crossing of pathways sometimes seen may have been the result of an attempt by the neuromuscular mechanism to correct a movement not directed into the more comfortable position of IP. Lateral variations of postures or the envelopes of motion were possibly due to varying degrees of dominance of the action of muscles of one side over that of the other. Anteroposterior variations in posture, however, may not only have been due to a dominance of the action of one group of muscles over that of another, but also may possibly have been simply anatomical in origin.

While some minor differences were found in the gum chewing task, as in the tooth tapping task, common characteristics were observed in the envelopes of motion of all planes of the non-bruxist and bruxist groups. Whether the characteristic was the direction of motion, the smoothness of the pathways, the sudden changes in direction, the shapes of the envelope, the precision of the IP or the posture of the envelopes, examples of each of the variations of these features were present sufficiently frequently in both groups to make differentiation of non-bruxist envelopes of motion from those of bruxist subjects impossible and therefore making the task of attempting to quantify these features not worthwhile.

However, the opening phase was most commonly anterior in direction to the closing phase as in the empty mouth experiments. This is contrary to the finding of Schweitzer that the opening phase was usually posterior to the closing phase when a bolus of food was present and only became anterior occasionally as chewing progressed. Perhaps this reflects the difference between the type of bolus being chewed, that is, 'rubbery' confectionery gum compared with food of a more plastic consistency.

The shape of the envelopes resembles to some extent those described by Shepherd who found 'tear-drop' shaped envelopes in the coronal plane of 'normal' subjects and distorted envelopes of motion in subjects with TMJPD. In the present study, non-bruxist and bruxist subjects were found to have both types of shapes of envelopes of motion in the coronal plane together with a third type – a 'modified tear-drop' shape in the form of a long narrow envelope. Whether a direct comparison can be made of the two studies is doubtful because of the differences between gum chewing and food mastication. However, a further reason for such differences between the 'normal' group in the Shepherd study and the non-bruxist group in this (in relation to envelopes of motion in the coronal plane) was the use of improved equipment and techniques which have developed in the twenty-five year interval, such as CCTV which has a much higher sampling rate than cinephotography, the type of indicator and the manner of its attachment.

Differences in the opening phase being to the left or the right of the closing phase may be due to whether the subject chewed the bolus on the left or the right side of the mouth. Shepherd commented on similar observations, but offered no explanation. However, Gibbs and co-workers commented that the closing path was further from the midline than the opening path in the chewing pattern of adults and that the envelopes were postured towards the bolus or working side.

Others such as Ahlgren and Hedegard also believed that the posture of the envelope in the coronal plane was towards the side on which the bolus of food was chewed. However, some subjects in this study did not conform to these ideas (Fig. 2). It might be possible that either direction or posture may be dependent on the side on which the bolus is chewed, but not both. If both were dependent on the side on which the bolus was chewed, if direction changed, so would posture, and as seen in Fig. 2, this is not always so. These findings warrant further investigation for an explanation is not clear. Neither is the explanation for the appearance of relatively upright envelopes of motion, where chewing still occurs on one side.

The regularity of opening and closing paths was demonstrated by the composite traces, where a...
series of consecutive cycles marked coincident pathways, resulting in heavily inked areas on the X-Y recording. This occurred in the closing phase in some of the non-bruxist subjects (Fig. 3), and indicated a more regular approach path to IP than the departure path in opening. In the bruxist group, the common pathways in the composite traces were seen more frequently in both the departure and approach paths from and to IP in the intercuspal zone (Fig. 4). The more regular paths in both the departure from and approach to IP shown by these bruxists may have reflected the greater need for precise movements to escape the cuspal interference more commonly noted by Nasedkin, Xhonga, Gage, and Ramfjord. However, detailed examination of occlusal contacts, minor interferences, and so on, was not carried out in this study. The occlusion was examined for attrition facets only as a means of indicating bruxism, but because many of the subjects were relatively young the presence of attrition facets was considered too unreliable as an absolute indicator.

The horizontal view which has been briefly described by only a few workers proved to be very useful in confirming the observations from the coronal and sagittal views, and in a number of cases made some aspects of an envelope easier to interpret because it completed the three dimensional picture of the movement (for example, wide envelopes of motion seen in this plane may have been due either to some envelopes being more open laterally in the coronal plane (Fig. 5) or, alternatively, to a posture away from the vertical axis in the coronal plane (Fig. 6). Differentiation between these
may be made by the position of IP in the envelope — in the former case IP is centrally placed along its lateral path, while in the latter, IP is placed near the right extremity of the envelope of motion.

**Summary**

A study of some kinesiological characteristics of the mandible of non-bruxist and bruxist subjects was carried out using a closed circuit television point movement tracking system. The use of incandescent light bulbs attached to the incisor teeth of the maxilla and mandible as the point movement source allowed records to be made without head restraint of the subjects examined. Records were stored on magnetic tape.

Mandibular movement was studied using the vertical, lateral and anteroposterior components of movement. Two components of movement were combined electronically for all three combinations of the components and the signals produced were used to prepare envelopes of motion graphically, on an X-Y recorder, in the coronal, sagittal and horizontal planes.

Qualitative analysis of envelopes of motion in three planes mutually at right angles proved useful in providing information which demonstrated trends to minor differences between non-bruxist and bruxist subjects. However, variations of patterns of movement occurred frequently enough in each test of each group to negate any possibility at present of using these techniques in the development of diagnostic procedures.

**References**


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