Intraoral Occlusal Telemetry
III. Tooth Contacts in Chewing, Swallowing and Bruxism

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It is critical in the study of occlusion to avoid cumbersome recording devices which trigger artificial neuromuscular reactions and create artifacts which could be interpreted as being physiologic. In recent years1-6 it has become possible to study the dynamics of occlusion with miniaturized electronic equipment without interfering with normal function. A telemetric system developed in our laboratory registers occlusal contact in three to five different areas on the same tooth.7, 8 The multifrequency transmitter device used for this purpose is small enough to fit into the space of one missing molar. Some findings regarding the occurrence and frequency of single and gliding tooth contacts during chewing and swallowing and during bruxism are presented here.

Materials and Methods

The details of the telemetric system and a description of the recordings it produces appeared in two earlier reports.7, 8 The miniature transmitter consists of an oscillator, battery and a multilayered switch which can activate the oscillator at three to five different frequencies. The oscillator is activated only when one of the switch layers contacts a small gold inlay inserted into a cusp tip of the opposing tooth. The emitted signals are picked up by a wire antenna which is worn loosely around the neck and fed into receivers which are connected with a six-channel oscillograph.

Incidence of swallowing is recorded by a strain gauge around the subject's neck producing a characteristic recording pattern which can be correlated with tooth contacts. A telegrapher's key connected to the oscillograph can be used as an event marker and to register observed chewing strokes and swallowing. To create minimal awareness on the part of the subject, there is no equipment on the subject's head or face and no head fixation.

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This report is from an investigation supported by the Research and Development Command, Office of the Surgeon General, Department of the Army under Contract Number DA-49-193-MD-2614.

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Six adults with a full complement of teeth except for one missing molar were selected as experimental subjects. All had posterior contacting tooth surfaces on both sides.

There were no signs of abnormal tooth mobility or clinical signs or symptoms of temporomandibular and neuromuscular disturbances. All of the subjects had a discrepancy between a posterior contact position (centric occlusion*) and maximum intercuspation (habitual occlusion*). In each subject miniature transmitting devices were built into two interchangeable bridges, which replaced the missing tooth without interfering with the occlusion. In one bridge, the switch was positioned in the sagittal plane so that it recorded tooth contacts in habitual occlusion and 0.75 mm anterior to it and up to 2.25 mm posteriorly. In the other bridge, the switch was positioned in the coronal plane so that it recorded contacts in the central fossa and 0.75 mm buccal and lingual to it. This enabled us to study protrusive, retrusive, and right and left lateral single tooth contacts and glides and to compare the frequency and duration of tooth contacts in centric occlusion and habitual occlusion (Fig. 1).

To check the reliability of the system and alignment of switches, tooth contacts were studied under different and repeated conditions, such as opening and closing with and without instruction and with manual guidance by the operator. After preliminary tests, recordings were made with subjects eating a hamburger unassisted and uninstructed, and with subjects bruxing.

*Centric occlusion: intercuspted occlusion with the mandible in centric relation. Habitual occlusion: intercuspted occlusion with the mandible out of centric relation. These terms are used only for purposes of communication and to describe the position of the mandible, without implying any particular significance in the physiology of occlusion.

Figure 1. Left: Bridge in situ with switch aligned anteroposteriorly. Right: Bridge in situ with switch aligned buccolingually.
FINDINGS

The findings of four subjects are presented here.

Tooth Contact Patterns in the Sagittal Plane While Eating Hamburger

Subject A (Male, Age 38)

This subject incised, chewed and swallowed six bites of hamburger in 235 seconds. The single and gliding anteroposterior contacts recorded during this period are shown in Figure 2. There were 293 chewing strokes of which 227 occurred with tooth contact. There were 158 gliding contacts from habitual occlusion anteriorly (HA-158), and 66 single contacts anteriorly to habitual occlusion (A-66). The posterior position was contacted once at the beginning of a protrusive glide (PHA-1). Twelve swallows were recorded, eight of which occurred with tooth contact in habitual occlusion. Of these, three were single contacts (H-3), three were glides from habitual posteriorly (HP-3), and two were glides from habitual anteriorly (HA-2). There were also two swallows with a single contact anterior from habitual occlusion (A-2), and two with a glide from the anterior position into habitual (AH-2).

Subject B (Male, Age 25)

This subject required 225 seconds to incise, chew and swallow ten bites of hamburger. The single and gliding anteroposterior contacts recorded during this period are shown in Figure 3. Tooth contact occurred in 109 of the 270 recorded chewing strokes. Sixty-two were single contacts in habitual occlusion (H-62).

Tooth contact occurred 0.75 mm posterior from habitual occlusion 46 times, 16 were single contacts (P-16) and 30 were glides. Of the latter, 18 were from habitual posteriorly (HP-18), 11 were from the posterior position to habitual (P,H-11) and one was from the anterior position to habitual and then posteriorly (AH-1). Contact 1.50 mm posterior from habitual occlusion was recorded once as a part of a glide (HP-1). The most posterior position (P3), 2.25 mm beyond habitual occlusion was not reached during chewing and swallowing.

There were 11 swallows, 6 occurred without contact, 5 with contact. Of the latter, 4 were 0.75 mm posterior from habitual occlusion (P-4), and one swallow was in habitual occlusion.

Subject C (Male, Age 38)

This subject required 195 seconds to incise, chew and swallow eight bites of hamburger. The single and gliding anteroposterior tooth contacts recorded during this period are shown in Figure 4. Tooth contact occurred in 139 of 181 chewing strokes. Of these, 123 were single contacts into habitual occlusion (H-123), 13 were gliding contacts in which habitual occlusion was involved. Ten were from the anterior position into habitual (AH-10) two from the posterior position (PH-2) and one from habitual into the posterior position (HP-1). There were also three single chewing contacts in the posterior position (P-3).

There were 14 swallows, tooth contact occurred in 13, 12 were single contacts in habitual occlusion (H-12) and one was a glide from habitual into the posterior position (HP-1).

Subject D (Female, Age 44)

This subject required 275 seconds to incise, chew and swallow ten bites of hamburger. The single and gliding anteroposterior tooth contacts recorded during this period are shown in Figure 5.

Tooth contact occurred 206 times in 215 chewing strokes. There were 69 single contacts and 137 gliding contacts. Forty-six single contacts were in habitual occlusion (H-46), 23 in the anterior position (A-23). Of the glides, 54 went from the anterior position to habitual occlusion and returned anteriorly (AHA-54); 42 were from the anterior position into habitual (AH-42); 23 were from habitual anteriorly (HA-23); five were from the anterior position, to habitual and then posteriorly (AH-5); one was from habitual posteriorly (HP-1), one was from the posterior position to the anterior posi-
FIGURE 3. Schematic illustration of single and gliding occlusal contacts in the sagittal plane of Subject B (Male, age 24) eating hamburger. Tooth contacts are recorded in habitual occlusion (H), 0.75 mm posterior from habitual occlusion (P1), 1.50 mm posterior from habitual occlusion (P2), 2.25 mm posterior from habitual occlusion (P3) and 0.75 mm anterior from habitual occlusion (A).

FIGURE 4. Schematic illustration of single and gliding occlusal contacts in the sagittal plane of Subject C (Male, age 36) eating hamburger. Tooth contacts are recorded in habitual occlusion (H), 0.75 mm posterior (P) and 0.75 mm anterior from habitual occlusion (A).

Teeth contact occurred in 24 of 25 swallows. Twelve were single contacts in habitual (H-12), one was a single contact in the anterior position (A-1), eight were glides from anterior into habitual (AH-8), two were glides from habitual anteriorly (HA-2), and one was a glide from habitual posteriorly (HP-1).

Tooth Contact Patterns in the Coronal Plane While Eating Hamburger

Subject A (Male, Age 38)

Three hundred ten seconds were required to incise, chew and swallow eight bites of hamburger. The single and gliding buccolingual tooth contacts recorded during this period are shown in Figure 6.

Two hundred twenty-six contacts were recorded in 326 chewing strokes. There were 117 single contacts, 33 in habitual occlusion (H-33), 80 lingually (L.L.-80), and 4 buccally (L.B.-4). There were 109 gliding contacts. Forty-one were from lingual to buccal through habitual (L.L-H-L.B.-41); 36 were from habitual to lingual (H.-L.L.-36); 16 were from lingual to habitual (L.L-H-16); 9 were from buccal to lingual through habitual (L.B.-H.L.L.-9); 5 from habitual buccally (H.L.B.-5) and 2 were from lingual to buccal without contact in habitual (L.L-L.B-2). The teeth contacted in
FIGURE 5. Schematic illustration of single and gliding occlusal contacts of Subject D (Female, age 44) in the sagittal plane eating hamburger. Tooth contacts are recorded in habitual occlusion (H), 0.75 mm posterior (P) and 0.75 mm anterior (A) from habitual occlusion.

Upon all 12 swallows. Ten were glides, from lingual to buccal through habitual (L.L-H-L.B-10), one was from habitual lingually (H-L.L-1) and one was from the lingual to habitual (L.L-H-1).

Subject B (Male, Age 25)

Two hundred thirty-five seconds were required to incise, chew and swallow 11 bites of hamburger. The single and gliding buccolingual tooth contacts recorded during this period are shown in Figure 7.

There were 136 tooth contacts in 281 chewing strokes. One hundred thirty-four of these were single contacts, 133 occurred in habitual occlusion (H-133) and one was buccal from habitual (L.B-1). There were two gliding contacts from buccal to habitual (L.B-H-2).

Tooth contact occurred in only two of 14 swallows. Both were single contacts into habitual occlusion (H-2).

Subject D (Female, Age 44)

One hundred seventy seconds were required to incise, chew and swallow eight bites of hamburger. The single and gliding buccolingual tooth contacts recorded during this period are shown in Figure 8.

There were 123 tooth contacts in 140 chewing strokes. Eighty-seven of these were single contacts and 36 were glides. Of the single contacts 47 were lingual to habitual (L.L-47), 27 were in habitual occlusion (H-27) and there were 13 buccal to habitual (L.B-13). Of the glides, 21 were from lingual to habitual (L.L-H-21), 9 were from buccal to habitual (L.B-H-9), 4 were from habitual buccally (H-L.B-4) and 2 were from lingual to habitual (H-L.L-2).

FIGURE 6. Schematic illustration of single and gliding occlusal contacts in the coronal plane of Subject A eating hamburger. Occlusal contacts are recorded in habitual occlusion (H) and 0.75 mm lateral buccal (L.B) and 0.75 mm lateral lingual (L.L) from habitual occlusion.
TELEMETRIC TOOTH CONTACT PATTERNS

FIGURE 7. Schematic illustrations of single and gliding occlusal contacts in the coronal plane of Subject B eating hamburger. Tooth contacts are recorded in habitual occlusion (H), 0.75 mm lateral buccal (L.B.) and 0.75 mm lateral lingual (L.L.) from habitual occlusion.

buccal through habitual (L.L.-H-LB-2). Tooth contact occurred ten times in 14 swallows. Seven were single contacts in habitual occlusion (H-7) and three were single contacts lingual to habitual (L.L-3).

FIGURE 8. Schematic illustration of single and gliding occlusal contacts in the coronal plane of Subject D eating hamburger. Occlusal contacts are recorded in habitual occlusion (H) and 0.75 mm lateral buccal (L.B.) and 0.75 mm lateral lingual (L.L.) from habitual occlusion.

BRUXISM

Recordings were made while bruxing with the switches aligned in the coronal plane to compare the buccolingual contacts with those obtained during eating a hamburger. Recordings during bruxing movements differed mark-

FIGURE 9. Tracing of occlusal contacts while bruxing with the switch placed to record buccolingual mandibular movement (Subject D). The three labeled recording channels indicate tooth contact in habitual occlusion (hab.) and 0.75 mm buccal (lat. buccal) and lingual (lat. lingual) to it. Deflections from the horizontal lines indicate tooth contact.

FIGURE 10. Tracing of occlusal contacts while eating a hamburger with the switch placed to record buccolingual mandibular movement (Subject D). Contacts are recorded in habitual occlusion (hab.) and 0.75 mm buccal (lat. buccal) and 0.75 mm lingual (lat. lingual) to habitual. Swallowing is registered on the top line (s). Marked on the tracing, reading from right to left, are the following tooth contacts: a single contact lingual to habitual (l.l), a single contact buccally (l.b), two single chewing contacts in habitual (h₁ and h₂) and a longer contact during swallowing (h₃). Two glides from lingual to habitual (l.l to h₁) and (l.l to h₂).
edly from those obtained during eating. Bruxing was characterized by repetitive side to side movements with the teeth in contact on all recorded occlusal areas. Figure 9 is a tracing characteristic for bruxing movements. It depicts bruxing as a series of gliding movements which uniformly contact habitual occlusion and positions buccal and lingual to it. Comparable lateral gliding contacts do not occur when the same patient eats hamburger (Fig. 10).

**DISCUSSION**

With the miniaturized telemetric system used in this study, it was possible to study the occlusion without introducing artifacts that may result from the usual registration equipment. However, our findings can only be interpreted as the individual patterns of the experimental subjects, all of whom had a missing tooth which was replaced by a fixed bridge. They may or may not be typical of a representative sampling of normal occlusions. Different types of recordings would also be obtained with foods of different consistency than the hamburger used in this study.

Of the 681 chewing contacts in the sagittal plane, tooth contact occurred 15 times in centric occlusion (posterior position), eight of which are accounted for by subject D. Of the 62 swallows recorded for all subjects in the sagittal plane, five occurred in centric occlusion. Centric occlusion did not appear to be an active functional position in chewing or swallowing.

The infrequency of tooth contact in centric occlusion during swallowing is particularly interesting. All subjects demonstrated the capacity to reach centric occlusion with a conscious effort before recordings were made during eating. Centric pathway prematurities may have inhibited the use of centric occlusion.

Also of interest is the fact that of 62 swallows more (8) occurred without tooth contact than with the teeth in centric occlusion (5). Swallowing without tooth contact was a highly individual matter because in six of the eight instances it occurred in the same subject.

We are not suggesting that there is no place for centric relation in dental practice but it appears that the so-called habitual occlusion is really the working occlusion during mastication. It is the position in which the teeth contact most often in chewing and swallowing.

In 959 chewing strokes for all subjects in the sagittal plane there were 681 recorded tooth contacts of which 588 were in habitual occlusion and 15 in centric occlusion. In 62 swallows for all subjects in the sagittal plane 51 tooth contacts occurred in habitual occlusion. A more realistic term such as “functional occlusion” should be sought for the position currently described as “habitual” or “convenience” occlusion. The latter term implies it is a detour rather than the common functional position our findings indicate it to be.

The many contacts anterior to the “habitual occlusion” cast some doubt on the practice of confining consideration of the functional physiology of occlusion to two occlusal positions (centric and habitual).

Gliding contacts do occur in the coronal plane in some chewing strokes but lateral excursions are not typical of the chewing cycle. Of 485 tooth contacts in the coronal plane (buccal-lingual), 338 were of a single nature (non-gliding) and 147 were gliding contacts. Of the latter, 95 involved two surfaces and 52 involved three surfaces.

Bruxism consists of repetitive grinding contacts suggestive of purposeful stimulated mandibular movements rather than the haphazard pattern of tooth contact during mastication. It appears that bruxism is a specific directed neuromuscular phenomenon rather than a simple accentuation of normal mastication.

**CONCLUSIONS**

Studies of tooth contacts in chewing, swallowing and bruxism using a multifrequency intraoral telemetric system led to the following conclusions regarding the subjects studied:

1. Centric occlusion (posterior position) was used infrequently in chewing and swallowing.
2. Most chewing and swallowing occurred in the “habitual” occlusion which might more appropriately be designated the “functional occlusion.”
3. Lateral excursions are not typical of the chewing cycle.
4. Bruxism consisted of regular repetitive grinding tooth contacts which differed from the haphazard pattern recorded during mastication.

**REFERENCES**