Anterior Guidance: Its Effect On Electromyographic Activity of the Temporal & Masseter Muscle

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Reprinted from The Journal of Prosthetic Dentistry, Vol. 49, No. 6, pp. 816-823, June 1983

In his classic article D'Amico[1] states: "When canines are in normal interlocking position, the lateral and forward movement is limited so that when an attempt is made to move the mandible laterally or forward, there is an involuntary reaction when the canines come in contact. The reaction is an immediate break in the tension of the temporal and masseter muscles, thus reducing the magnitude of the applied force. Regardless of how hard the individual tries to tense these muscles, as long as the canines are in contact, it is impossible for these muscles to assume full tension." He continues: "The length of the roots of the canines and the anatomical structure of the supporting alveolar process gives testimony to nature's intention as to the function intended. What may appear as trauma as they come in contact is not trauma at all, because when contact is made, muscular tension is involuntarily reduced, thus reducing the magnitude of applied force."

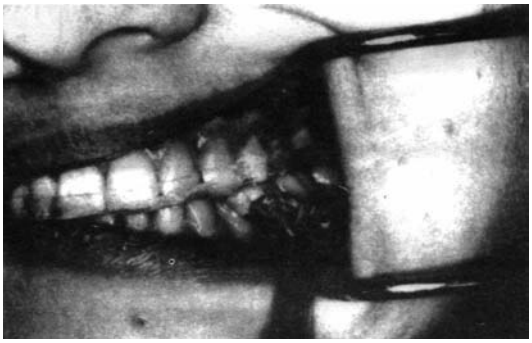

Figure 1 – Maxillary splint with verified occlusal contacts.

The purpose of our study was to determine the effect of two occlusal schemes on the temporal and masseter muscles. The first occlusal scheme used anterior guidance to eliminate all contact of posterior teeth in eccentric movements. The second occlusal scheme allowed selective posterior occlusal contact in eccentric movements. These occlusal schemes were developed using maxillary occlusal splints.

In addition, it was desired to determine if the contact of the canines or the elimination of posterior tooth contacts reduced muscle tension.

Material And Methods

Five subjects, all women, were selected. Four subjects reported a history of dysfunction or pain associated with the temporomandibular joint. The history of the fifth subject was negative for symptoms normally associated with temporomandibular joint dysfunction.

Accurate maxillary and mandibular casts were developed. A facebow was used to mount the maxillary cast on an arcon-type articulator. An interocclusal registration was made while using a leaf gauge[2] with the technique reported by Williamson et al.,[3] and the mandibular cast was mounted on the articulator. A maxillary acrylic resin splint was developed using the "sprinkle on" technique with relief from undercuts provided by adapting 0.001-inch lead foil over the maxillary cast. An arbitrary anterior guidance was developed on the articulator. The mandibular cusps that occlude in centric occlusion (centric cusps) contacted a flat maxillary occlusal plane developed by the splint. The splint was adjusted in the mouth for retention by relining with autopolymerizing acrylic resin. The occlusion was developed with the splint so that all opposing contacting teeth held 0.0005 shim stock with the condyles physiologically seated in the mandibular fossae (Figure 1). The anterior guidance was adjusted so that all posterior teeth discluded during eccentric movements as determined by articulating tape.

Surface electrodes from a Teca EMG unit (Teca Corp., Pleasantville, N.Y.) were attached to the right and left temporal and masseter muscles. The electrodes to the temporal muscles were placed 1 inch posterior and 1 inch superior to the outer canthus of the eye. The location of the electrodes to the masseter muscles was determined by palpation, and they

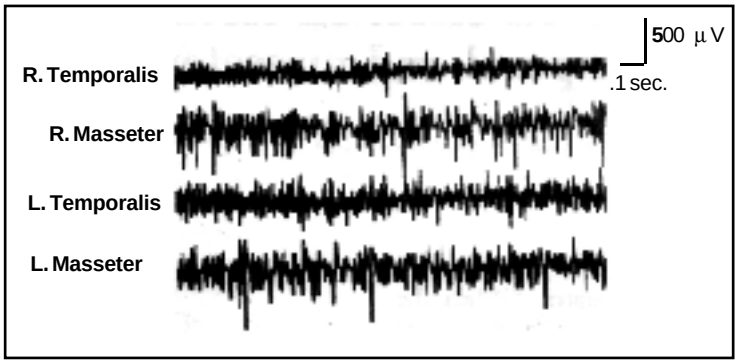

Figure 2 – Muscle activity while subject was biting against splint with mandible in retruded contact position (centric relation). All muscles demonstrated electromyographic activity.

were placed on the body of the muscle midway between the origin and insertion. The subjects were comfortably seated in an upright position. Recordings were printed with a paper speed of 10 cm/sec and a microvoltage of 500 µV.

All recordings were produced in the same sequence for both occlusal schemes. The subject was instructed to close firmly and maintain pressure against the splint while moving into right laterotrusion, back to retruded contact position, into left laterotrusion, back to retruded contact position, and then into protrusion.

Following the tests for the first occlusal scheme, the anterior guidance was eliminated by adjusting the occlusal splint with an acrylic resin bur until contact of the posterior teeth was established in eccentric movements. Then the tests with the second occlusal scheme were conducted.

Recordings were made of each subject without the splint, using the same sequence to provide a standard for comparison.

RESULTS

Anterior guidance provided by the splint

Figure 2 is a recording produced as subject C.B. was biting against the splint in the retruded contact position (centric relation). All recorded muscles demonstrate marked electromyographic activity.

Figure 3 demonstrates electromyographic activity as the same subject made a left laterotrusive movement without the splint. The posterior teeth remained in contact during the movement. All muscles continued to respond with marked electromyographic activity.

The splint was reinserted and the subject instructed to execute a left laterotrusive movement (Figure 4).

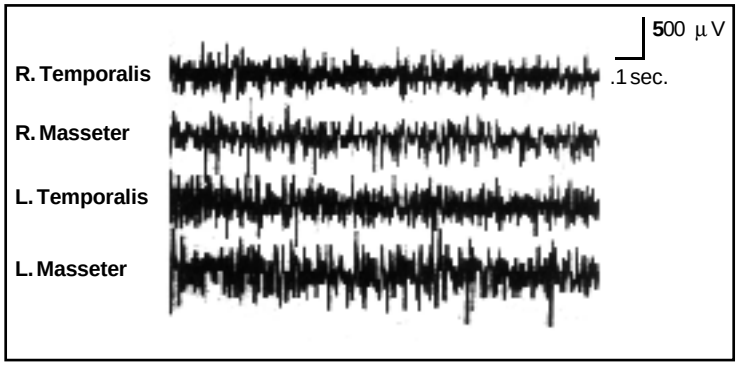

Figure 3 – Electromyogram made during a left laterotrusive movement with natural dentition in contact. All muscles were actively contracting.

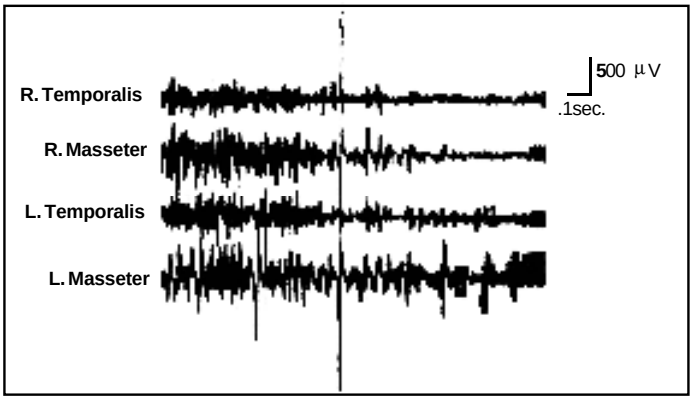

Figure 4 – Electromyogram made during a left laterotrusive movement with splint providing anterior guidance and posterior disclusion. Posterior disclusion was initiated by vertical line. Reduced activity was recorded.

Once movement was initiated, the only occlusal contact was between the left canine and the splint. As the movement was executed, there was an immediate decrease in electromyographic activity of all muscles. The greatest reduction of activity was seen in the right temporal and masseter muscles. There was a significant reduction in activity of the left temporal muscle. Some activity continued in the left masseter muscle, but the amplitude was greatly reduced.

Figure 5 is the recording of the subject C.B. executing a right laterotrusive movement without the splint and with the posterior teeth in contact. There was continuous involvement of all muscles during this movement.

In Figure 6, a right laterotrusive movement with the splint in position and occlusal contact only on the right canine, a pattern similar to the left laterotrusive movement with the splint was recorded. Once movement was initiated, the muscles of the laterotrusive side showed a decrease in amplitude; but the decrease was not as marked as that of the mediotrusive side. This continuous activity at a decreased amplitude on the laterotrusive side was noted on four of the five subjects. The four subjects had a history of previous problems associated with the temporomandibular joint.

Marked differences were noted between the electromyographic activity of the involved muscles as the subject made a protrusive movement without the

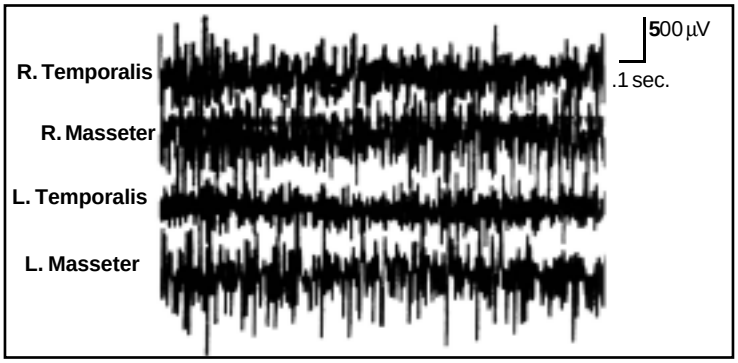

Figure 5 – Electromyogram made while same subject as in Fig. 4 executed a right laterotrusive movement with natural dentition in contact. All muscles were involved.

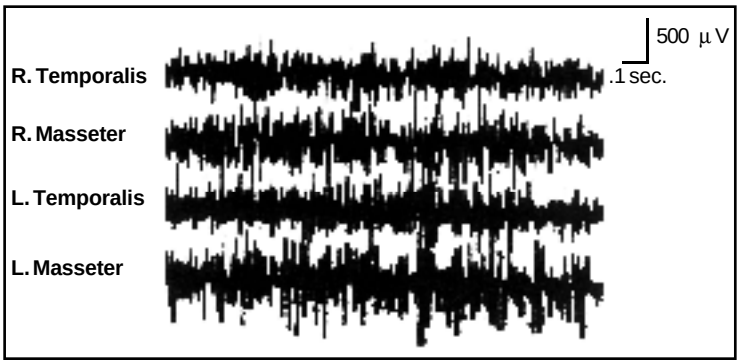

Figure 6 – With splint inserted, electromyogram shows a significant decrease in activity as a similar movement as depicted in Fig. 5 was executed.

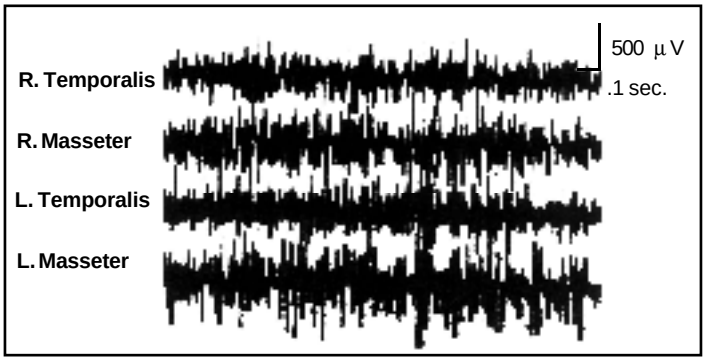

Figure 7 – Electromyogram made during a protrusive movement with teeth in contact. Activity continued throughout range of movement.

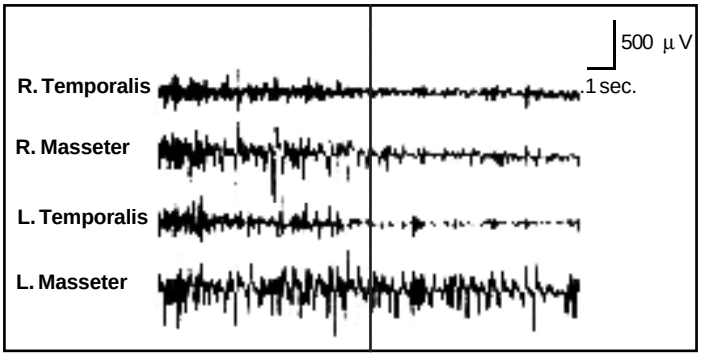

Figure 8 – Splint provided anterior guidance in this protrusive movement. Decreased activity was noted as posterior teeth discluded (vertical line).

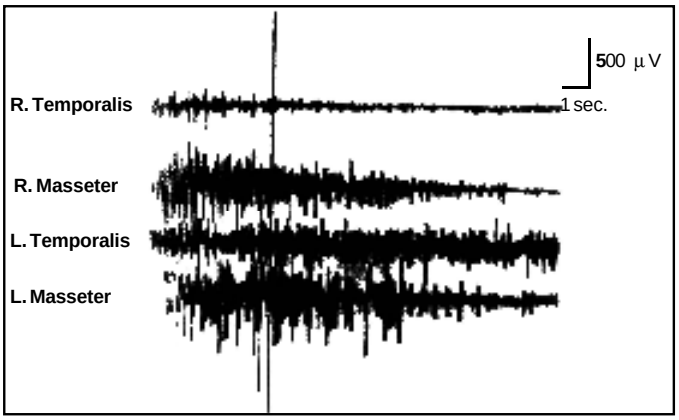

Figure 9 – This subject had a relatively good occlusion with few posterior contacts in eccentric movements. Electromyogram shows decreased activity as most posterior teeth discluded (vertical line) during left laterotrusive movement.

splint (Figure 7) and with anterior guidance between the splint and the upper anterior teeth (Figure 8). Significant decrease in all muscle activity was noted except for the left masseter muscle. It is postulated that splint therapy prior to these recordings would have produced an effect that would have shown greater reduction in electromyographic activity.

Subject S.M. showed the pattern of electromyographic activity associated with an individual who has not had a history of temporomandibular joint involvement. This subject had an occlusion with an anterior guidance that allowed only minimal contacts of posterior teeth in eccentric movement. Figure 9 is a recording made during a left laterotrusive movement without a splint, and Figure 10 is a recording with the splint providing anterior guidance.

Anterior guidance eliminated from the splint

When the anterior guidance of the splint was eliminated, bilateral posterior contacts between the teeth remained during the laterotrusive, mediotrusive, and protrusive movements. A typical example of these recordings is seen in Figures 11 and 12. Figure 11 is a recording made of subject J.S. during a right laterotrusive movement with the splint providing anterior guidance. Minimal electromyographic activity continued when the anterior guidance discluded the posterior teeth. No decrease in activity is observable in Figure 12 after the anterior guidance was removed, except for the right temporal muscle.

Figure 13 is the recording made during a protrusive movement with anterior guidance provided by the splint for subject J.S. When the anterior guidance

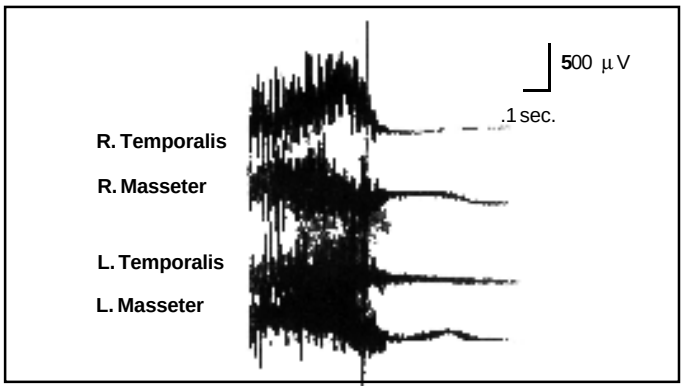

Figure 10 – When splint was inserted in same patient as in Fig. 9 and all posterior teeth discluded (vertical line), a dramatic decrease in electromyographic activity was observed.

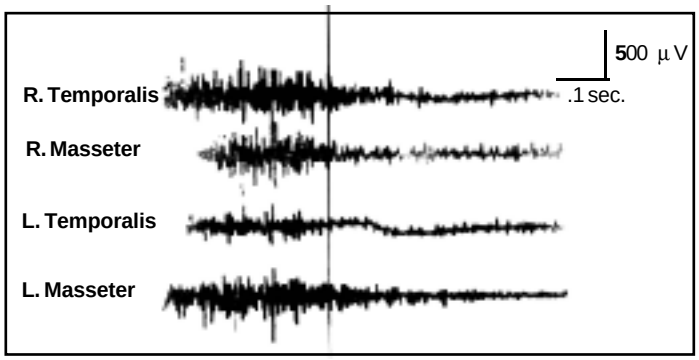

Figure 11 – Electromyogram made during an eccentric movement while splint provided anterior guidance. Vertical line indicates disclusion of posterior teeth.

was eliminated from the splint and posterior contacts remained, greater activity in the muscles was noted. (Figure 14).

Canine contact versus posterior tooth contacts

On one subject, S.M., with the splint positioned and providing anterior guidance, one piece of shim stock 0.0005 inch in thickness was placed over the right or mediotrusive side as the patient moved into a left laterotrusive position. Figure 15 demonstrated that both masseter muscles continued to record high amount of electromyographic activity while the activity from both temporal muscles was markedly reduced. Note the difference in Figure 10, which shows the muscle activity while subject S.M. made a left laterotrusive movement with the splint providing anterior guidance and posterior disclusion.

Discussion

In a previous study reported by Williamson,[4,5] symptomatic patients were treated using similar types of splints until the patients became asymptomatic. The electromyographic recordings were made. These recordings demonstrated an even greater reduction in the electromyographic activity of the temporal and masseter muscles on the mediotrusive side with anterior guidance. The masseter muscle on the laterotrusive side also showed a marked reduction in activity. The temporal muscle on the laterotrusive side always produced greater electromyographic activity than the masseter muscle. When the anterior guidance was eliminated and posterior guidance established, there was no apparent decrease in muscular activity on either the laterotrusive or mediotrusive side of either muscle.

When leaf gauges were used to prevent posterior tooth contacts, minimal activity was recorded in the masseter muscles.[3] The temporal muscles remained active, indicating their function as positioning muscles.

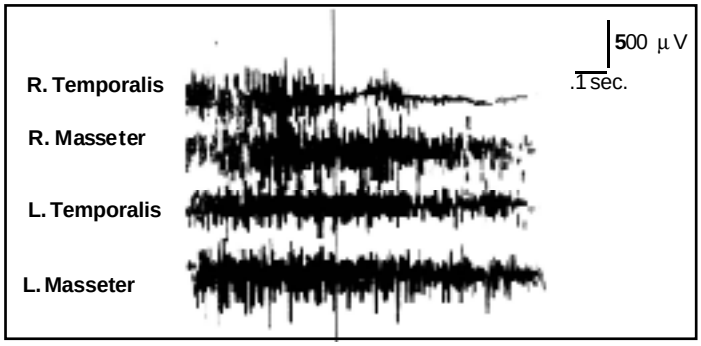

Figure 12 – With anterior guidance eliminated, no decrease in electrical activity occurred for same patient as in Fig. 11.

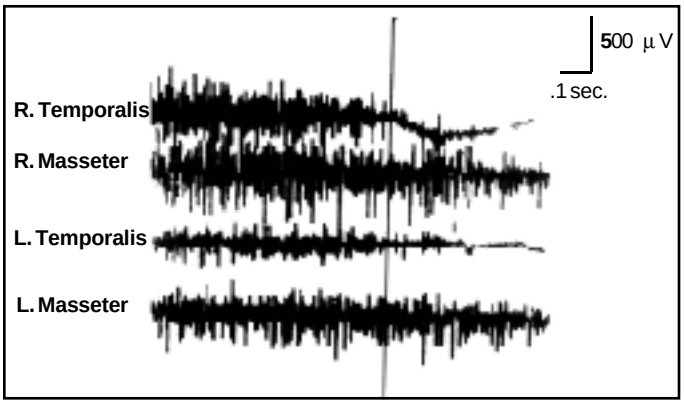

Figure 13 – Electromyogram made during a protrusive movement with anterior guidance shows some decrease in activity.

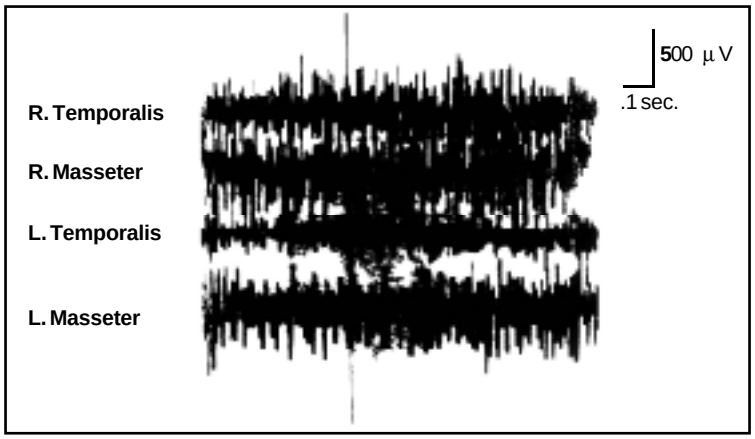

Figure 14 – With anterior guidance removed. Electromyogram for same patient as in Fig. 13 shows no decrease in activity for protrusive movement.

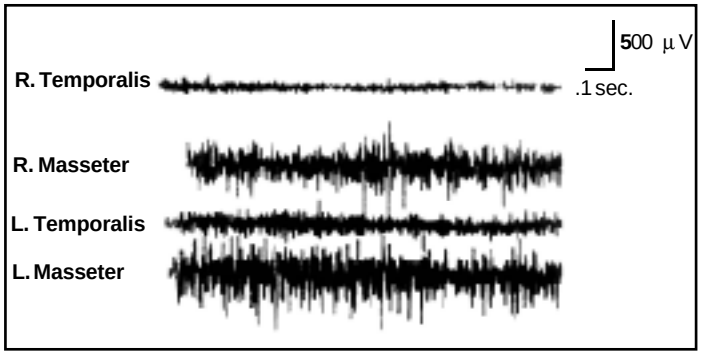

Figure 15 – With a piece of shim stock on right occlusal surface, electromyogram made during a left laterotrusive movement shows that both masseter muscles remained very active.

During eccentric movements, forces are applied to posterior teeth that are not directed to the midvertical axis when they remain in contact.6 Only when posterior disclusion is obtained by an appropriate anterior guidance can the electromyographic activity of the elevating muscles be reduced. This would eliminate all lateral forces to the posterior teeth except those that would be present in the intercuspal position.

Occlusion may alter muscular activity. Gibbs, et al.7 demonstrated that condylar position and movement, the path of mandibular closure, and the sequence of the timing of mandibular movement in a chewing cycle were modified by the occlusion of each subject. Additional research will determine all factors of occlusion that will provide patients with the most physiologic range of muscular activity.

Conclusions

The results of this investigation indicate that only when posterior disclusion is obtained by an appropriate anterior guidance can the elevating activity of the temporal and masseter muscles be reduced. Further, it is not the contact of the canines that decreases the activity of the elevator muscles, but the elimination of posterior contacts.

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