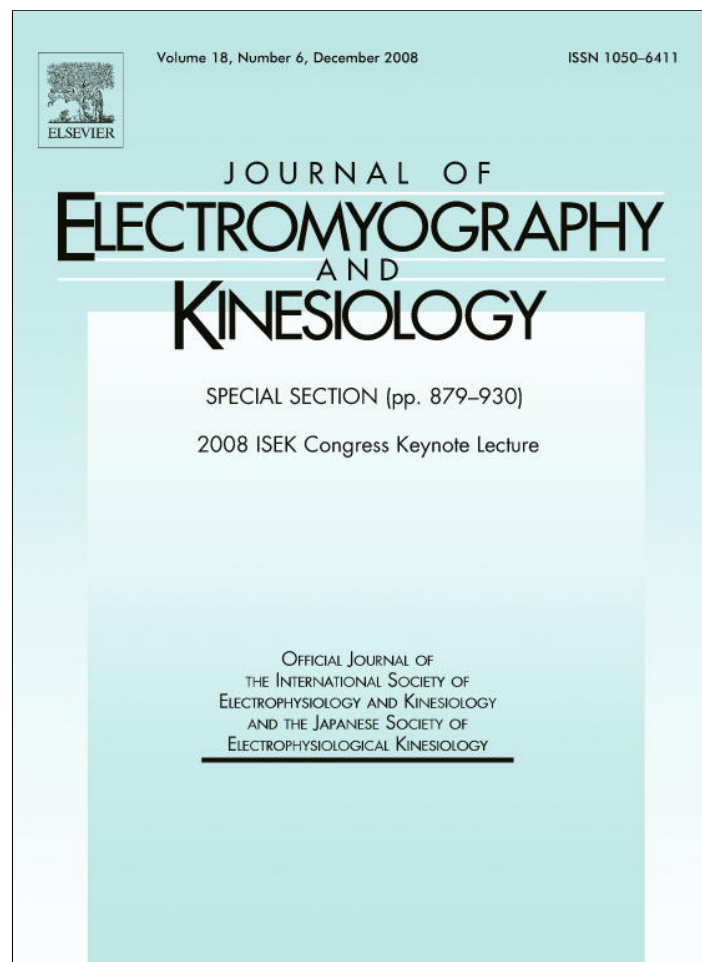


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Journal of Electromyography and Kinesiology 18 (2008) 947–954

 JOURNAL OF
 ELECTROMYOGRAPHY
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Jaw elevator silent periods in complete denture wearers and dentate individuals

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Received 8 February 2007; received in revised form 30 May 2007; accepted 30 May 2007

Abstract

Functional meaning and underlying mechanisms of jaw elevator silent period (SP) have still not been completely understood. Since complete denture wearers (CDWs) have no periodontal receptors in their jaws, the aim was to examine SPs in CDWs and to compare it with dentate individuals (DIs).

Thirty six DIs (skeletal/occlusal Class I) and 24 eugnath CDWs participated. EMG signals were registered using the EMGA-1 apparatus from the left and the right side anterior temporalis (ATM) and masseter muscles (MM). Ten registrations of an open-close-clench (OCC) cycle were obtained for each individual. DIs had the average latency between 12.5 and 12.9 ms and always one single short inhibitory pause (IP) with complete inhibition of motoneurons (20.1–21.1 ms). On the other hand, in CDWs various types of SPs emerged: single or single prolonged SPs, double SPs, SPs with three IPs, periods of depressed muscle activity following the first, or the second IP, SPs with relative inhibition of motoneurons or even in several registrations the SP was missing. Unless more than one IP emerged, complete duration of inhibitory pauses (CDIP) was measured. CDIP varied from 37.17 to 42.49 ms. Average latencies were from 16.22 to 16.76 ms. Based on the results of this study it is obvious that both, the duration and the latencies were significantly longer in CDWs than in DIs ($p < 0.05$), which can be explained by different mechanisms responsible for the muscle reflex behaviour.

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Keywords: Silent period; Natural teeth; Complete denture wearers; Temporalis and masseter muscle; OCC cycle; EMG

1. Introduction

The silent period (SP), or an inhibitory reflex, is a cessation or complete inhibition of motoneuron activity following a stimulus in a contracting muscle (Alghren, 1969; Hoffman, 1919; van Steenberghe, 1979; Türker, 1988). In masticatory elevator muscles SP commences after functional contacts of the opposing teeth or after some other stimulus applied to oral and perioral region during the muscle contraction (Graven-Nielsen et al., 2000; Griffin and Munro, 1969; Haraldson and Ingerwall, 1979; Helsing and Klineberg, 1983; Hoffman, 1919; Jacobs and van Steenberghe, 1995; Sharav et al., 1982; van Steenberghe, 1979; Türker, 1988).

The mechanisms involved in the latency and the duration of the inhibitory reflex have not yet been completely explained. Although some authors attribute SP eliciting mainly to periodontal receptors' stimulation and/or muscle unloading, it is possible that other receptors play a role in that process (Alajbeg et al., 2005; Bessette et al., 1971; Brenman et al., 1968; Brodin et al., 1991; Cadden and Newton, 1992; Chong-Shan and Hui-Yun, 1989; Ciancaglini et al., 1989; Dessem et al., 1988; Freesmeyer, 1987; Di Francesco et al., 1986; Griffin and Munro, 1971; Jacobs and van Steenberghe, 2006; Kossioni and Karkazis, 1998, 1999; De Laat et al., 1985; Lavigne et al., 1983; Schaerer et al., 1967; Tallgren et al., 1987; Türker and Miles, 1985, 1989; Türker et al., 1994; Türker and Jenkins, 2000; Yoshida, 1998; Widmalm and Hedegard, 1976; Widmalm and Ash, 1985; Yemm, 1972).

The SP has been a subject of extensive investigation because of its potential diagnostic significance in cases of

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craniomandibular dysfunction (CMD). It had been postulated that SP had a longer duration in the patients with CMD than in the healthy individuals and that it might be a tool of diagnostic and prognostic interest (Bessette et al., 1971; Chong-Shan and Hui-Yun, 1989; Widmalm and Hedegard, 1976). On the contrary, other studies could not prove the prolongation of the silent period in CMD patients and even claimed that the duration of the SP is shorter in CMD patients due to the increased muscular tonus (Hellsing and Klineberg, 1983; De Laat et al., 1985; Lavigne et al., 1983; Sharav et al., 1982). The upper limits of a prolonged SP also varied from study to study, and so did the methods used for SP eliciting (Alajbeg et al., 2005; Alghren, 1969; Bernstein et al., 1981; Bessette et al., 1971; Brenman et al., 1968; Brodin et al., 1991; Cadden and Newton, 1992; Chong-Shan and Hui-Yun, 1989; Ciancaglini et al., 1989; Dessem et al., 1988; Freesmeyer, 1987; Di Francesco et al., 1986; Fung et al., 1982; Gottlieb et al., 1984; Graven-Nielsen et al., 2000; Griffin and Munro, 1969, 1971; Haraldson and Ingerwall, 1979; Hellsing and Klineberg, 1983; Hoffman, 1919; Jacobs and van Steenberghe, 1995, 2006; Kamogawa et al., 1988; Karkazis and Kossioni, 1999; Kossioni and Karkazis, 1995a,b, 1998, 1999; De Laat et al., 1985; Lavigne et al., 1983; Louca et al., 1996, 1998; Lund, 1991; Matthews and Yemm, 1970; Miles et al., 1987; Muller et al., 1993; Nagasava et al., 1976; Olsson and Westberg, 1989; Schaerer et al., 1967; Sharav et al., 1982; van Steenberghe, 1979; van Steenberghe and Jacobs, 2006; Tallgren et al., 1987; Türker, 1988; Türker and Miles, 1985, 1989; Türker et al., 1994; Türker and Jenkins, 2000; Yoshida, 1998; Widmalm and Hedegard, 1976; Widmalm and Ash, 1985; Yemm, 1972). Since a range of normal values has not yet been universally accepted, the debate seems to go on forever, because many are skeptical about the specificity of the methods as stimulation of afferents from various receptors elicits SPs (Chong-Shan and Hui-Yun, 1989; Di Francesco et al., 1986; Graven-Nielsen et al., 2000; Griffin and Munro, 1969, 1971; Jacobs and van Steenberghe, 1995; Kossioni and Karkazis, 1995a,b, 1998, 1999; De Laat et al., 1985; Lavigne et al., 1983; Schaerer et al., 1967; Tallgren et al., 1987; Türker, 1988; Türker and Miles, 1985, 1989; Türker et al., 1994; Türker and Jenkins, 2000; Yoshida, 1998; Widmalm and Hedegard, 1976; Widmalm and Ash, 1985; Yemm, 1972). The duration of the SP can also be slightly modulated through the input from the receptors at remote sites in the body (Cadden and Newton, 1992).

Because complete denture wearers (CDWs) have lost all their natural teeth and have no periodontal receptors left, it is believed that their neuromuscular feedback mechanisms may be impaired and that CDWs would be unable to provide enough sensory information to restore all natural feedback mechanisms for proper motor function or to fully compensate for normal tooth loading and force transfer (Jacobs and van Steenberghe, 2006). Explanation and possible differences of some reflex mechanisms and parameters between dentate individuals (DIs) and CDWs have still not

been completely distinguished (Brodin et al., 1991; Hellsing and Klineberg, 1983; Kossioni and Karkazis, 1995b, 1998; Matthews and Yemm, 1970; Tallgren et al., 1987).

The aims of this study were to broaden the knowledge about the SP and to compare SPs elicited in open-close-clench (OCC) cycles between DIs and CDWs, as well as to try to explain possible differences.

2. Materials and methods

2.1. Subjects

Twenty four well adapted CDWs (14 women, 10 men) and 36 DIs with all teeth, normal occlusal relationship, skeletal Class I and without any occlusal interferences (20 women, 16 men) participated. The exclusion criteria included previous history of myofascial pain syndrome (MPD) or CMD and of any disease that might have affected neuromuscular performance. The subjects were not taking any prescription medications and they were not currently undergoing treatment for any medical problem. Their individual weight and height was also within the normal limits for their age and sex group. All of the subjects were fully informed of the experimental procedures before their consent was obtained. The age range was between 50 and 76 years in CDWs and between 20 and 37 years in DIs. In CDWs the existing dentures were 1–3 years old, all patients were satisfied, and without any complaints. Their respective dentures had satisfactory interocclusal and maxilomandibular relationship and all of them reported an adequate masticatory efficiency. Their oral mucosa was free of irritation or any clinical signs of inflammation.

2.2. EMG recording and procedure

EMG registrations were performed on the eight channel PC-based EMG apparatus (EMGA-1) apparatus, which is a PC-controlled multichannel system for simultaneous surface myoelectric and gnathosonic signal registration and analysis. The instrument was directly interfaced with a computer which presented the data graphically and stored them on a hard disc for further quantitative and qualitative analyses. This system allowed simultaneous recording of myoelectrical activity from six muscles (six differential EMG channels, input impedance 100 M Ω , CMRR > 95 dB at 50 Hz, bandwidth 2 Hz to 1 kHz, programmable input sensitivity from 100 μ Vpp to 20 mVpp, an 12-bit resolution A/D conversion, 2 kHz sampling rate). The EMG activity was recorded from the right (RAT) and the left anterior temporalis (LAT) muscle and the left (LM) and the right (RM) masseter muscle. During registration it was possible to alter the duration of the recorded sequences (from 240 ms to 2.4 s).

Audio signals were recorded with one electret microphone (type EU-6, sensitivity 10 mV/Pa at 1 kHz, diameter 9.5 mm). The microphone was connected to audio amplifiers (bandwidth 10 Hz to 4 kHz, 2nd order Bessel type filters). Low frequency cut-off for myoelectric signals was set at 10 Hz.

Due to different spectral contents, myoelectric and gnathosonic signals were digitized at different sampling rates (20 kHz per channel for EMG and 60 kHz per channel for audio signals). The microphone for occlusal sound (audio) registrations was firmly attached over the skin of the most prominent part of the zygomatic bone by the adhesive tape.

Disposable surface disc electrodes (Ag/AgCl, diameter 8 mm) were placed 2.0 cm apart in the main direction of muscle fibres. In order to reduce skin impedance, the skin was carefully cleansed prior to electrode placement and a conductive paste was applied. Recordings were performed 5–6 min later, allowing the conductive paste to adequately moisten the skin surface. The impedance was checked until it was less than 30 k Ω . The common ground electrode was clipped to the left wrist. Standardization of electrode placement and reproducibility of EMG data considering between-session variation has been explained previously (Alajbeg et al., 2005, 2006; Celebic et al., 1996, 2007).

Firstly, the subjects clenched with the maximum voluntary contraction (MVC) for 2.4 s and repeated this three times with 30-s intervals of rest at the intercuspal position (ICP). The maximum value between the three clenching activities at ICP was considered as referent value. During EMG recording, the EMG device was connected to the clenching level indicator, which was used for visual feedback information about the clenching level. It was an additional unit, which rectified and smoothed the amplified myoelectric signal obtained from one of the amplifiers of the EMG device and by switching on a corresponding number of light emitting diodes it visualized the average myoelectrical activity. The clenching level indicator was set to display ten light emitting diodes during maximum voluntary activity in ICP. Each of the light emitting diodes corresponded to the 10% of the maximum muscle activity during clenching in ICP.

Afterwards, 10 open-close-clench cycles were registered for each individual. The duration of the recorded sequences of each OCC cycle was 300 ms. Recordings were triggered by the onset of the myoelectric activity of the right anterior temporalis muscle. The trigger threshold was adjusted individually by a cursor, depending on the level of individual myoelectrical activity displayed on the screen. On average, during spontaneous performing of OCC tasks six to seven light emitting diodes were switched on, presenting 60–70% of the maximum ICP activity. All individuals were instructed to perform 60% of maximum ICP activity during OCC tasks and they practiced this performance for several minutes, with at least 2 min of rest prior the final registrations.

The simultaneously recorded EMG and audio signals were displayed on the PC screen in separate windows allowing visual control of each signal. After the visual control (if any record had an artifact, it was excluded), the signals were stored on the hard disk, or a compact disk (CD-R) for the off-line analysis. The software Medwin, devised for EMGA-1 apparatus enabled off-line cursor measurements. The duration (time elapsed between the two cursors) and/or the voltage (root mean-square values (RMS) or average (U_{avg}) voltages) between the cursors were directly calculated and displayed on the screen between any position of the two cursors. In order to obtain better resolution (the best possible 4 μ s) for the optimal cursor positioning during measurements of the SP latency and the SP duration the zoom-in option was used.

2.3. SP measurements

Silent periods were elicited in open-close-clench (OCC) cycles. The OCC cycle is defined as a cycle when an individual from the open mouth position firmly closes the mouth and the teeth come into occlusal contact in the habitual occlusal position. Ten subsequent OCC cycles were registered for each individual, because in our previous study, relating to intra- and inter-individual variability and inter and intraobserver's reliability it had been con-

cluded that it was enough to comprise 10 consecutive OCC cycles to obtain representative values of the silent period parameters (Celebic and Valentic-Peruzovic, 1996). The EMGA-1 device and its software made it possible to superimpose the trace of the occlusal sound over the trace of muscle activity and to measure the duration of the signal or the mean voltage of the signal directly on the screen between the cursors. The SP latency and duration measurement was done at double zoom in option. The measurement error for the latency was 0.6 ms and for the duration 1.2 ms (Celebic and Valentic-Peruzovic, 1996). All measurements were made off-line, by a trained and experienced examiner. The latency of the SP was measured from the commencement of the occlusal sound trace to the peak of the last significant spike of muscle activity preceding the inhibition. The duration of the SP was measured from the peak of the last significant spike preceding the inhibition to the peak of the first significant spike being a part of the ongoing muscle activity. If a silent period with two or three inhibitory pauses appeared (double or tripple SP), or a silent period with a depressed muscle activity (DA) after complete inhibition of motoneurons, then the complete duration of all inhibitory pauses (CDIP) was measured or CDIP together with the duration of a DA after the last inhibitory pause.

2.4. Statistical analysis

From the obtained data, a statistical analysis was made. For the ability to perform a parametric test, normality of distribution was tested by the one-sample Kolmogorov–Smirnov test. Mean values (\bar{x}) and standard deviations (SD) were calculated. *t*-Test for independent samples was used to test the significance of the difference between the group with natural dentition and complete denture wearers. Statistical analysis was conducted at $p < 0.05$ level of significance.

3. Results

Results for the latency and duration of a silent period in DIs and in CDWs are shown in Table 1. The SP latency varied from 12.5 to 12.9 ms in DI group and from 16.22 to 16.76 ms in CDWs. The SP duration varied from 20.1 to 21.19 ms in DI group and from 37.17 to 42.49 ms in CDWs. In the DI group only one inhibitory pause emerged, of a short and complete inhibition of motoneuron activity (Table 1 and Fig. 1). Significantly longer latency and duration of inhibitory pauses (CDIP) for all of the examined muscles were recorded in CDWs than DIs ($p < 0.001$; Table 1).

Types, latencies and durations of inhibitory pauses, as well as percentage of different types of SPs registered in CDWs are shown in the Table 2. The CDWs exhibited various types of SPs: single or single prolonged SPs (D1), double SPs (D2), SPs with three inhibitory pauses (D3), periods of depressed muscle activity following the first, or the second inhibitory pause (D1DA, D2DA), SPs of relative inhibition of motoneurons, even in several registrations the SP was missing. In those registrations where more than one inhibitory pause was registered a complete duration of all inhibitory pauses was measured, together with the muscle activity between them (CDIP). The most frequent were

Table 1
Mean values (\bar{x}), standard deviations (SD) and range (min–max) for the latency and the duration of a silent period in individuals with natural teeth ($n = 36$) and in complete denture wearers ($n = 24$)

	Dentate individuals		Complete denture wearers	
	\bar{x} (ms) \pm SD	Min–max	\bar{x} (ms) \pm SD	Min–max
<i>Latency</i>				
Right anterior temporalis	12.91 \pm 1.20	9.8–15.2	16.76 \pm 1.79**	13.0–20.6
Right masseter	12.52 \pm 1.21	9.4–15.1	16.34 \pm 1.42**	13.5–20.2
Left anterior temporalis	12.91 \pm 1.26	9.4–15.3	16.74 \pm 1.78**	13.8–22.6
Left masseter	12.49 \pm 1.29	9.5–15.4	16.22 \pm 1.50**	14.8–23.2
<i>Duration</i>				
Right anterior temporalis	20.10 \pm 3.29	12.0–29.2	42.49 \pm 15.21**	22.4–66.6
Right masseter	20.48 \pm 3.19	12.9–29.1	37.17 \pm 16.81**	22.5–79.2
Left anterior temporalis	20.51 \pm 3.14	12.0–28.3	41.70 \pm 16.70**	23.8–68.0
Left masseter	21.19 \pm 3.07	12.0–29.0	40.16 \pm 15.96**	23.5–68.5

** Significantly different from individuals with natural teeth at $p < 0.001$.

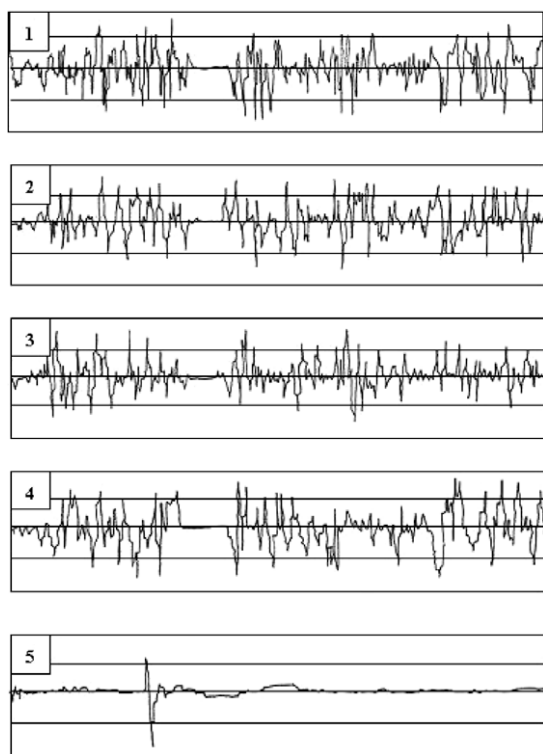


Fig. 1. Silent period in jaw elevator muscles in individuals with natural dentition. (1) Right anterior temporalis; (2) right masseter; (3) left anterior temporalis; (4) left masseter; (5) occlusal sound trace.

the silent periods with one prolonged inhibitory pause, of approximately 30 ms of duration, in more than 90% registrations. SPs with one inhibitory pause and the depressed muscle activity (DIDA) following the inhibition before the return of a normal muscle activity were registered in 6–15% cases (41.09–60.37 ms), depending on the muscle. Double silent periods were registered in 8–12% depending on the muscle (duration of approximately 60 ms; Table 2 and Fig. 2). The double SPs followed by the depressed muscle activity or the SPs with three inhibitions were registered in only few cases (from 0% to 2.7%; Table 2 and Fig. 2). In

some registrations the SP was even missing (1.08–8.11%) (Table 2).

4. Discussion

Our results revealed that SPs elicited in DI group always had only one inhibitory pause of a short duration with the complete inhibition of motoneuron activity (20.1–21.19 ms). The latencies varied between 12.5 and 12.9 ms and were similar to the latencies elicited in other studies by a menton tap (Ciancaglini et al., 1989; Karkazis and Kossioni, 1999; Kossioni and Karkazis, 1995a,b, 1998, 1999), but were shorter than the latencies of SPs elicited by electrical stimulation of the tooth pulp (Sharav et al., 1982), the lower lip (20 ms) (Türker, 1988; Türker and Miles, 1985) or by mechanical stimulation of the hard palate (50 ms) (Di Francesco et al., 1986) and the skin over the masseter muscle (54 ms) (Yemm, 1972). Due to the short latency in DI group (Table 1), the reflex may be considered to be oligosynaptic. The occlusal contact vibration could trigger any receptor located in the head, periodontal ligament, muscles, temporomandibular joints (TMJ) or tendons, the inner ear, etc., therefore it is not possible to distinguish a particular receptor responsible for SP eliciting.

Although CDWs have lost the receptors previously located in the periodontal ligament, the results of this study revealed that SPs could still be elicited in OCC cycles. Different mechanisms may be responsible for SPs in CDWs than DIs, such as mechanical pressure of the oral mucosus receptors under the dentures. However, the vibration of the opposing artificial teeth contacts could also stimulate other receptors. Significantly longer latencies in CDWs than in DIs (on average 2 ms) (Figs. 1 and 2 and Table 1) could be attributed either to the triggering of different receptors (mucosal vs. periodontal), possible slower conduction velocity of the mucosal receptors, or that more synapses were involved in the reflex arch. The additional period after occlusal contact necessary for a denture to shift to the underlying mucosa and stimulate the receptors may also

Table 2

Latency and duration of different types of silent periods and the percentage of inhibitory pauses of the silent period in complete denture wearers

	Right temporalis		Left temporalis		Right masseter		Left masseter	
	<i>x</i>	%	<i>x</i>	%	<i>x</i>	%	<i>x</i>	%
<i>Latency</i>								
L1	16.96	92.43	16.74	91.89	16.54	98.92	16.52	94.59
L2	40.51	8.65	36.64	11.35	34.12	12.43	40.40	8.11
L3	98.20	1.62	68.16	2.70	78.9	1.08	68.00	1.08
<i>Duration</i>								
D1	35.57	93.43	32.31	91.89	30.85	98.92	32.09	94.59
D1DA	47.21	8.11	60.37	5.95	41.09	11.31	46.09	15.13
D2	59.60	8.65	58.34	11.35	60.34	12.43	66.37	8.11
D2DA	32.40	0.54	*	*	85.00	0.54	*	*
D3	121.30	1.62	93.16	2.7	102.3	1.08	98.00	1.08
Complete duration	41.49	92.43	40.7	91.89	35.97	98.92	39.76	94.59
Missing		7.57		8.11		1.08		5.41

L1, L2, L3 = latency of the first, the second or the third inhibitory pause; D1, D2, D3 = duration of the first, the second, or the third inhibitory pause; D1DA, D2DA = duration till the end of inhibitory pause together with the depressed muscle activity following inhibition, but before the commencement of normal muscle activity; * = parameter missing; *x* = mean; % = percentage.

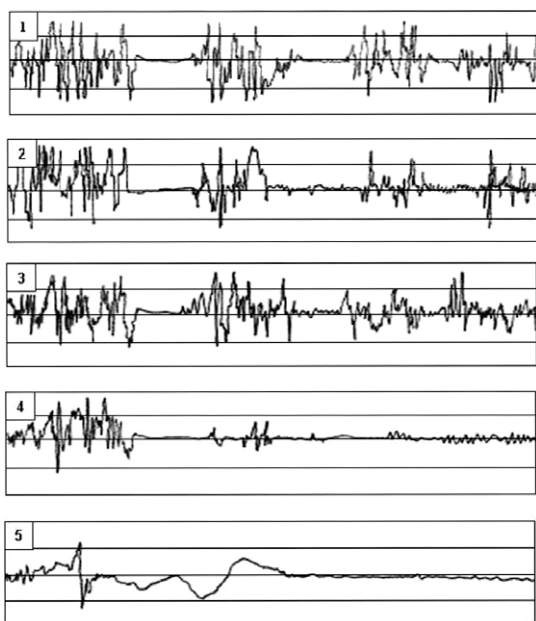


Fig. 2. Silent period in jaw elevator muscles in complete denture wearers. (1) Right anterior temporal muscle; (2) right masseter; (3) left anterior temporal muscle; (4) left masseter; (5) occlusal sound trace.

be responsible. If vibration is responsible for SP eliciting, then the transmission of vibration might be slower through the acrylic resin teeth. The CDWs were also of an older age than DIs, consequently aging might have slowed down motor responses and increased individual variations. Previous studies have shown that both, the age and the extent of rehabilitation with dentures have affected the reflex latencies during chin tapping (Kossioni and Karkazis, 1995a,b, 1998). Some authors (Matthews and Yemm, 1970; Nagasava et al., 1976) elicited SPs of 13 ms latencies during OCC cycles in CDWs, which was shorter than in this study. The authors had not reported the material of artificial teeth. Their patients might have had porcelain

teeth and consequently a brisker vibration. However, minimum values in CDWs and maximum values in DIs sometimes overlapped in this study. In the chin-tapping experiments with CDWs other authors (Kossioni and Karkazis, 1995b, 1998; Tallgren et al., 1987) described slightly longer latencies (1–2 ms) than in DIs.

Concerning the duration of the SP, the results of this study revealed that in CDWs various types of SPs emerged: single or single prolonged SPs (D1), double SPs (D2), SPs with three inhibitory pauses (D3), periods of depressed muscle activity following the first, or the second inhibitory pause (D1DA, D2DA), SPs of relative inhibition of motoneurons, even in several registrations the SP was missing (Fig. 2 and Table 2). In those cases with more than one inhibitory pause, complete duration of all inhibitory pauses was measured (CDIP). The CDIP (Tables 1 and 2) in CDWs was significantly longer than in the DIs (on average 40 ms vs. 20 ms) ($p < 0.01$). The CDWs sometimes displayed different types of SPs simultaneously in each of the four muscles examined; the SP appeared as a prolonged one in one muscle and the double one in the other. Some authors also recognized different types of the SP in CDWs; e.g. double SPs (SPs with two inhibitory pauses), or prolonged single SPs after chin taps (Tallgren et al., 1987), double SPs after the electrical stimulation of the lower or the upper lip (Türker and Miles, 1985; Yemm, 1972), the tooth pulp (Sharav et al., 1982), and in tapping experiments of a single tooth in the perpendicular direction to the vestibular surface (Brodin et al., 1991). Some authors (Karkazis and Kossioni, 1999; Kossioni and Karkazis, 1995a,b, 1998, 1999) recognized four types of SPs after chin tapping: simple and double SPs, SPs with progressively increasing activity at the end and double SPs with progressively increasing activity at the end. Triple SPs have also been described in the literature (Brodin et al., 1991). The SPs with progressively increasing activity, or double SPs with progressively increasing activity Karkazis and

Kossioni (1999) correspond to the single or the double SPs followed by a depressed muscle activity described in this study (D1DA or D2DA). Various types and duration of inhibition in CDWs could be due to the stimulation of the receptors of a different fiber conduction velocity and/or different number of synapses included. For instance, in a double SP, the first inhibitory pause could be elicited by triggering of one type of receptors and the second inhibitory pause by triggering of the other type of receptors with a slower conduction velocity and/or more synapses included. In this way, it is possible that the first inhibitory pause which had not been finished had actually merged with the second inhibition (which had a longer latency) into one single prolonged inhibitory pause.

Haraldson and Ingerwall (1979) registered SPs during OCC cycles with same latencies and slightly prolonged durations in the subjects with fixed prostheses on oral implants than in DIs. Contrary, Bonte and van Steenberghe (1991) were not able to elicit SPs in the implant patients with fixed prostheses without any teeth left. At the same time, they were able to register SPs in CDWs. They believed that the tooth tapping force in their experiments, delivered by means of a pendulum system in a perpendicular direction to the tooth's vestibular surface, was very low and could not elicit vibration, which explained the absence of SPs in the edentulous implant patients. Presence of SPs in CDWs was attributed to the stimulation of the mucosal receptors (Bonte and van Steenberghe, 1991; Jacobs and van Steenberghe, 2006; van Steenberghe and Jacobs, 2006). One group of authors elicited SPs by a tactile air-jet stimulation which deformed the oral mucosa of intraoral sites, moreover SPs had longer latencies the more posteriorly the receptor was located (Di Francesco et al., 1986).

It has been described that previous level of muscle activity affects the duration of the inhibitory reflex (Fung et al., 1982). Therefore, in this study all subjects had to perform OCC tasks with 60% of their maximal ICP activity. However, maximal myoelectric activity in ICP is significantly higher in DIs than in CDWs (Alajbeg et al., 2005, 2006; Castroflorio et al., 2006; Celebic et al., 1996, 2007), but individual variation cannot be avoided in any EMG measurement. The clenching levels (Alajbeg et al., 2005; Bernstein et al., 1981; Bonte and van Steenberghe, 1991; Celebic et al., 2007; Fung et al., 1982; van Steenberghe, 1979; Karkazis and Kossioni, 1999; Kossioni and Karkazis, 1995b, 1998, 1999; De Laat et al., 1985; van Steenberghe and Jacobs, 2006) have always been expressed as percentages of the maximum muscle activity in ICP. Moreover, the amplitudes of EMG signals depend not only on the subject variability, but also on the propagation of the muscle potentials to the electrode (amount of fat and connective tissue and the skin impedance) (Alajbeg et al., 2005; Castroflorio et al., 2006; Celebic et al., 1996, 2007; Kemsley et al., 2003).

Functional meaning of the SP is still the matter of a debate. The authors of the present study suppose that SP

allows muscle fibers to achieve optimal isometric contraction at a certain muscle fibre length. Periodontal receptors are certainly not the only receptors responsible for SP eliciting. However, if vibration was responsible for stimulating various receptors, then if it was brisk or short lasting (without any ongoing movements of the mandible) a short duration single SP appeared. Irregular SPs (double, triple, etc.) probably appeared when antagonistic teeth contact caused a prolonged vibration and/or minute mandibular sliding movements. Irregular SPs might have appeared if other different receptors were included, such as intraoral mechanoreceptors or pain receptors (Alghren, 1969; Bessette et al., 1971; Bonte and van Steenberghe, 1991; Brenman et al., 1968; Brodin et al., 1991; Cadden and Newton, 1992; Castroflorio et al., 2006; Chong-Shan and Hui-Yun, 1989; Ciancaglini et al., 1989; Dessem et al., 1988; Freesmeyer, 1987; Di Francesco et al., 1986; Fung et al., 1982; Gottlieb et al., 1984; Graven-Nielsen et al., 2000; Griffin and Munro, 1969, 1971; Haraldson and Ingerwall, 1979; Hell-sing and Klineberg, 1983; Hoffman, 1919; Jacobs and van Steenberghe, 1995, 2006; Kamogawa et al., 1988; Karkazis and Kossioni, 1999; Kossioni and Karkazis, 1995a, 1998, 1999). In this way, during the motoneuron inhibition, additional sensory impulses from other receptors or brain centres have enough time to arrive to the trigeminal motor neuron pool to allow achievement of the optimal strength at a given muscle fibre length or to cause changes of muscle fiber length and/or activation of antagonistic muscles. It has been known that the SP leads to a reduced muscle-force output, but it cannot be fully a "protective" reflex since the reduced force development occurs too late, due to the delay between the myoelectric phenomenon and the mechanical force output, which is on average 60 ms (van Steenberghe and Jacobs, 2006). Although there is an obvious difference in the SP parameters between DIs and CDWs, more experiments are necessary in order to fully explain the real significance of an SP and possible differences in the reflex muscle behaviour between the two groups.

Conflict of Interest Statement

None declared.

Acknowledgements

This study was supported by the Grants 065-0650446-0420, 065-0650448-0957, and 065-0650446-0435 from the Croatian Ministry of Sciences and Technology, Zagreb, Croatia.

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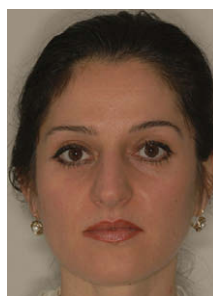
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