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# Jaw reflexes in healthy old people

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## Abstract

**Objective:** to investigate variations in the masseteric myotatic reflex (jaw-jerk) and the silent period from the 5th to the 9th decades of life.
**Subjects and methods:** electromyographic data were recorded from the masseter muscle of the preferred chewing side by surface electrodes, using a computerized recording and analysis system. Chin taps were applied with a neurologist's hammer during mandibular rest and at 40% intercuspal clenching in 30 healthy people aged from 49 to 87 years. The influence of age, gender and silent period type were analysed by multiple regression analysis ($P \leq 0.05$).
**Results:** even in the very old subjects all reflexes were elicited, at least once. However, with increasing age the overall occurrence of the jaw-jerk reflex at rest (%) and its amplitude, at rest and at clench, were reduced, while its latency at rest was significantly increased ($P \leq 0.05$). No age effects were recorded in most parameters of the jaw-jerk reflex at clench and in the silent period. Women showed a tendency for reduced latencies of the jaw-jerk and the early silent period and increased silent period duration ($P \leq 0.05$). They also had a steeper decline in myotatic reflex activity, particularly at rest.
**Conclusion:** simple masseteric reflex activity is maintained until very old age, particularly when elicited during contraction of the jaw elevators.

Keywords: *gender, jaw-jerk, masseter muscle, old age, silent period, stretch reflex, trigeminal nerve*

## Introduction

Chewing, swallowing and speech are differentially affected by ageing [1-3]. Our understanding how the nervous system controls oral motor behaviour is limited and even less is known about neuromuscular orofacial control in very old age. Age changes in oral motor performance are not as marked as in other parts of the body [3-5]. The study of simple jaw reflex activity in different age- and sex-groups can reflect on differences in the neuromuscular circuits that provide the basis for the more complex orofacial movements. The simple reflex responses are the masseteric myotatic reflex (or jaw-jerk) and the silent period. The jaw-jerk reflex is monosynaptic, analogous to the tendon jerk seen in the limb muscles and mediated through the trigeminal motor root [6], while the masseteric silent period is the transient decrease in electromyographic (EMG) activity elicited when a stimulus is applied during a sustained contraction. Both reflexes help in detecting subclinical lesions of the trigeminal system [7, 8]. Previous cross-sectional studies have shown some decline in simple jaw reflex activity between 20- and 60-year cohorts [9, 10]. The aim of the present study was to investigate variations in simple jaw reflex activity from middle to old age.

## Methods

### Sample

All participants were edentulous and wore complete dentures. The jaw-jerk and the silent period were elicited in 30 healthy subjects, aged between 49 and 87 years with a mean age of 68.4 years (14 men with a mean age of 67.3 years and 16 women with a mean age of 69.3 years). Participants were patients and staff of a university clinic and were fully informed on the experimental procedure before their consent was obtained. They were all fully independent and living at home. No subjects had signs or symptoms of stomatognathic system dysfunction that might affect jaw reflex activity. There was no history of disease or medication likely to affect neuromuscular activity.

The mean duration of edentulousness was 16.2 ± 13.02 years (range 3 months-50 years). All dentures were considered satisfactory by both the patient and the specialist who examined them using standard criteria (stability, retention, occlusion, vertical dimension). This ensured that the participants could efficiently clench their artificial teeth in centric occlusion during the experimental procedure and that they were able to chew, preventing disuse atrophy of their masticatory muscles.

### Recording technique and data analysis

Details on the electromyographic technique have been previously published [9-11]. Bipolar surface electrodes were secured unilaterally over the masseter muscle of the preferred chewing side (Duo-Trode, silver/silver chloride, Myo-Tronics Inc., Seattle, WA, USA). The EMG signals were differentially amplified 5000 times (500-10×; NL850 isolated pre-amplifier and NL104 AC Preamp differential main amplifier, Neurolog System Digitimer Ltd, UK), root-mean-square (RMS)- integrated (RMS Integrator NL705, Neurolog System Digitimer), with time constant set at 20 ms and simultaneously displayed on an oscilloscope screen (Hameg HM 205-3, Hameg Instruments, Frankfurt, Germany) for on-line observations. All signals passed into a 12-bit analogue/digital conversion board, with sampling frequency 2 KHz (DAS-1600 Keithley MetraByte, Keithley Data Acquisition, Taunton, MA, USA) driven by a commercial software package (Easyest LX, Asyst Software Technologies Inc., Rochester, NY, USA) on a personal computer.

The reflex was elicited with moderate taps applied with a neurologist's reflex hammer to the centre of the chin over a customized acrylic chin template, where a microsensor trigger was mounted. The microsensor triggered the computerized recording procedures on contact with the hammer. Fifteen to 20 downwards and backwards chin taps were applied to each subject at 30-60 s intervals during mandibular rest and during intercuspal clenching at 40% of the maximum masseteric clenching RMS activity, through visual feedback from the oscilloscope screen [11]. The trials were alternated between rest and clench condition. The reproducibility of the tap force, as well as the within- and between-session reproducibility of the jaw-jerk using the present experimental procedure have been found to be satisfactory [12].

The analysis was performed by the same trained examiner off-line using the commercial software package. The occurrence of the jaw-jerk at rest and the amplitude were estimated from the integrated RMS value of the signal, while all the other measurements were performed from the raw EMG.

#### *Jaw-jerk*

The latency of the jaw-jerk reflex was defined as the time from chin tap to the first distinct deflection from the preceding level of the signal. The duration was measured from the beginning of the first distinct deflection to the return to the baseline in the rest experiments or to the beginning of the silent period in the clench experiments. The amplitude was defined as the peak RMS value corresponding to the reflex event.

#### *Silent period*

Four different types of silent period were recorded: one simple and three combined (early and late phases). The combined silent periods were analysed in terms of occurrence, latency and duration of the early and late phases [10, 11].

The reproducibility of the method of analysis has been previously tested and found satisfactory [10-12].

### Statistical analysis

Mean values, standard deviations, minimum and maximum values were calculated. Multiple regression analysis was performed and $\beta$ coefficient tables calculated, using occurrence, latency, duration and amplitude of the reflex as continuous dependent variables and gender, age and silent period configuration as independent variables [13]. Thus, the associations between the dependent and the independent variables was assessed. The normality of the distribution of the dependent variables was tested by the use of the $X^2$ goodness of fit test [13]. The level of statistical significance was set at $P \leq 0.05$.

## Results

Unclear recordings of latency, duration or amplitude were excluded. When a reflex event was present, but could not be clearly measured, it was included in the occurrence measurements. This explains the within- and between-subject discrepancy in the number of observations calculated for each parameter.

The jaw-jerk and the silent period were recorded in all subjects, at least once. The silent period, was present in all subjects and in all observations (100%). All 30 subjects presented combined silent period types ($n = 30$, $x = 59 \pm 19.2\%$, range 20-100%), while the simple type was recorded in 29 subjects ($n = 30$, range 0-80%). Mean values, standard deviations, minimum and maximum values for both reflexes are presented in Tables 1-3. Observation of the mean values for the jaw-jerk showed that latencies generally increased with increasing age, while the mean occurrence and the amplitude decreased (Figures 1 and 2). Multiple regression analysis showed that age had a statistically significant influence on the occurrence and latency of the jaw-jerk at rest and also on its amplitude in both experimental conditions ($P \leq 0.05$; Table 4). The occurrence of the jaw-jerk at clench was reduced compared to rest in the middle-aged and the young old, but it was higher in those over 75 (Figure 1). Age had no significant influence on any of the silent period parameters studied (Table 5). The silent period type did, however, influence duration measurements (Table 5).

Gender affected the occurrence of the jaw-jerk at clench and its latency in both experimental conditions, as well as the early silent period latency and both early

Table 1. The masseteric myotatic reflex in older people

| | At rest | | | | At clench | | | |
|---|---|---|---|---|---|---|---|---|
| | *n* | Mean ± SD | Min | Max | *n* | Mean ± SD | Min | Max |
| Occurrence (%) | | | | | | | | |
| Men | 14 | 58.7 ± 32.0 | 13.3 | 100.0 | 14 | 57.4 ± 20.1 | 26.7 | 93.3 |
| Women | 16 | 69.0 ± 32.6 | 6.7 | 100.0 | 16 | 73.5 ± 27.3 | 7.1 | 100.0 |
| Total | 30 | 64.2 ± 32.2 | 6.7 | 100.0 | 30 | 66.0 ± 25.2 | 7.1 | 100.0 |
| Latency (ms) | | | | | | | | |
| Men | 12 | 7.9 ± 1.1 | 6.7 | 9.9 | 14 | 6.3 ± 0.7 | 5.3 | 7.2 |
| Women | 14 | 7.0 ± 1.2 | 5.2 | 9.5 | 16 | 5.2 ± 0.9 | 4.0 | 6.5 |
| Total | 26 | 7.4 ± 1.2 | 5.2 | 9.9 | 30 | 5.7 ± 1.0 | 4.0 | 7.2 |
| Duration (ms) | | | | | | | | |
| Men | 10 | 6.2 ± 1.6 | 3.0 | 8.7 | 14 | 7.5 ± 1.4 | 5.5 | 11.6 |
| Women | 13 | 6.9 ± 1.4 | 4.5 | 9.4 | 15 | 7.9 ± 1.6 | 6.0 | 11.4 |
| Total | 23 | 6.6 ± 1.5 | 3.0 | 9.4 | 29 | 7.7 ± 1.5 | 5.5 | 11.6 |
| Amplitude (V)[a] | | | | | | | | |
| Men | 13 | 0.2 ± 0.1 | 0.1 | 0.4 | 14 | 0.5 ± 0.2 | 0.3 | 0.7 |
| Women | 14 | 0.3 ± 0.2 | 0.1 | 0.6 | 16 | 0.6 ± 0.2 | 0.2 | 1.0 |
| Total | 27 | 0.2 ± 0.1 | 0.1 | 0.6 | 30 | 0.5 ± 0.2 | 0.2 | 1.0 |

[a]At the input to analogue/digital converter (amplification gain: 5000×).

and total silent period duration (Tables 4 and 5). The jaw-jerk was consistently commoner in women, the latencies were shorter (except for the latency of the second phase of depression), and silent period durations were longer (Tables 1-3, Figures 1 and 2). An interesting observation was the variable degree of decline in jaw-jerk reflex performance between sexes. In the women, latency, occurrence and amplitude of the jaw-jerk—particularly at rest—presented a steeper decline in performance than in the men from middle

Table 2. Analysis of the masseteric silent period in 30 older people (14 men and 16 women)

| | S | | M | | PIA | | M + PIA | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Group | *n* | Value | *n* | Value | *n* | Value | *n* | Value | *n* | Value |
| Frequency distribution by silent period type (%) | | | | | | | | | | |
| Men | - | 44.0 | - | 6.4 | - | 47.5 | - | 2.1 | - | 100 |
| Women | - | 38.4 | - | 10.3 | - | 46.2 | - | 5.1 | - | 100 |
| Total | - | 41.0 | - | 8.5 | - | 46.8 | - | 3.7 | - | 100 |
| Latency of the second phase of depression, ms (mean ± SD) | | | | | | | | | | |
| Men | - | - | 9 | 41.6 ± 13.8 | 14 | 39.2 ± 5.8 | 3 | 33.3 ± 6.6 | 14 | 38.9 ± 6.0 |
| Women | - | - | 8 | 45.3 ± 5.5 | 16 | 41.7 ± 8.3 | 8 | 40.0 ± 9.0 | 16 | 40.6 ± 6.9 |
| Total | - | - | 17 | 43.3 ± 10.6 | 30 | 40.6 ± 7.2 | 11 | 38.2 ± 8.7 | 30 | 39.8 ± 6.4 |
| Duration of early silent period, ms (mean ± SD) | | | | | | | | | | |
| Men | 13 | 32.1 ± 9.8 | 8 | 27.6 ± 10.8 | 14 | 27.5 ± 6.3 | 3 | 19.9 ± 2.1 | 14 | 28.9 ± 6.9 |
| Women | 16 | 40.2 ± 15.1 | 9 | 31.9 ± 5.1 | 16 | 31.2 ± 8.9 | 8 | 30.5 ± 7.7 | 16 | 32.8 ± 8.8 |
| Total | 29 | 36.6 ± 13.4 | 17 | 29.8 ± 8.3 | 30 | 29.5 ± 7.9 | 11 | 27.6 ± 8.2 | 30 | 31.0 ± 8.1 |
| Total duration, ms (mean ± SD) | | | | | | | | | | |
| Men | 13 | 32.1 ± 9.8 | 9 | 55.5 ± 23.5 | 14 | 38.9 ± 10.1 | 3 | 38.5 ± 10.5 | 14 | 39.5 ± 10.8 |
| Women | 16 | 40.2 ± 15.1 | 9 | 61.8 ± 10.4 | 16 | 47.5 ± 19.0 | 7 | 65.8 ± 16.4 | 16 | 46.8 ± 19.2 |
| Total | 29 | 36.6 ± 13.4 | 18 | 58.7 ± 17.9 | 30 | 43.5 ± 15.8 | 10 | 57.6 ± 19.4 | 30 | 43.4 ± 16.0 |

S, simple silent period; M, silent period with medial activity; PIA, silent period with progressively increasing activity at the end; M + PIA, combination of M and PIA types.

Table 3. Latency of the early silent period in 30 older people (14 men and 16 women)

| | Latency (ms) | | |
|---|---|---|---|
| | Mean ± SD | Minimum | Maximum |
| Men | 12.1 ± 0.9 | 10.7 | 13.4 |
| Women | 11.0 ± 0.8 | 9.4 | 12.5 |
| Total | 11.5 ± 1.0 | 9.4 | 13.4 |

age onwards; in old age reflex values were almost similar (Figures 1 and 2).

## Discussion

### Masseteric reflex activity in the old age

The most important finding is the persistence of both reflexes even in very old age. It is difficult to estimate the precise extent of age changes in jaw reflexes from very young to very old age, due to difficulties in sample selection. Although direct comparisons cannot be made with previous cross-sectional studies in young, middle-aged and younger old people [9, 10], it seems that the myotatic stretch reflex at rest shows a continuous decline from the 20s to the 90s, but is never completely abolished, while the silent period after middle age remains unchanged. Absence of various limb reflexes have been reported in apparently healthy elderly people [14-17]. However, the possibility of underlying pathology cannot be excluded [18].

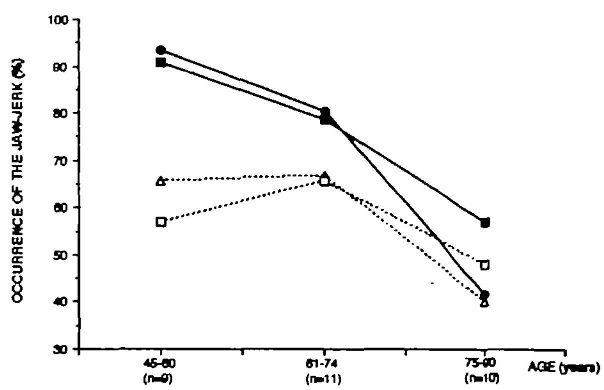


Figure 1. Occurrence (%) of the jaw-jerk reflex at rest (Δ, ●) and at clench (□, ■) in 14 men and 16 women grouped by age into 45-60 years, 61-74 years and 75-90 years. The women (filled symbols) show consistently higher mean values than the men (open symbols) in both conditions. However, they present a steeper decline in performance, particularly at rest after 75 years of age, and in old age similar values are recorded for both sexes.

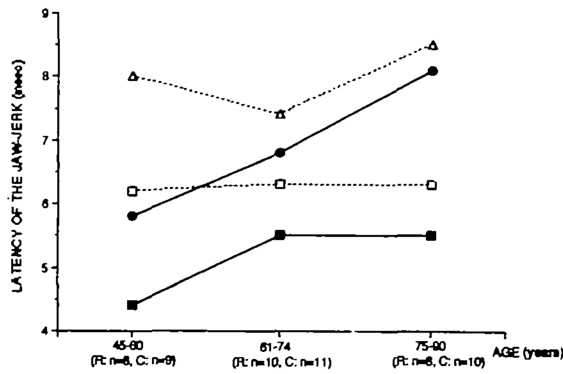


Figure 2. Latency of the jaw-jerk reflex at rest (R, Δ, ●) and at clench (C, □, ■) in 14 men and 16 women grouped by age into 45-60 years, 61-74 years and 75-90 years. Women (filled symbols) show consistently lower mean values than the men (open symbols) in both conditions, but present a steeper decline in performance, particularly at rest, and in old age the sex differences tend to diminish.

The neuromuscular system is subject to various age-related alterations. These are confined to the muscular tissue [19-23] and to the nervous system [18, 20, 24, 25]. The reflexes that we investigated are simple. Minor changes are expected in simple motor tasks, such as simple reflex activity where central processing is not involved [20, 26]. Latency of the stretch reflex at rest was increased with increasing age, in accordance with observations in other monosynaptic reflexes [25, 27]. Our data also suggest that during intercuspal clenching, the normal stretch reflex is maintained from middle to old age. In the very old, the jaw-jerk at clench was increased compared with that at rest: the opposite to what normally occurs.

The most prominent decline in masseteric reflex activity was recorded in participants aged 75 and over. In many aspects of neuromuscular control, age changes begin at 50-60 years, accelerate in the 70s and are more pronounced in the 80s [23, 24, 28, 29]. Reduction in tendon and superficial reflexes after age 70 was recorded by Howell [15], while Ongerboer de Visser and Goor [30] observed absence of the jaw-jerk reflex in five out of nine subjects over 70 years of age. Prakash and Stern [17] also noted absence of the jaw-jerk reflex in 52% of their sample with a mean age of 81.8 years. The bilateral absence of the jaw-jerk reflex even in contracting muscles has been considered a common finding in elderly people over 70 [7, 8, 30]. In all our subjects aged 70 years and over, the myotatic reflex was recorded at least once. This is possibly related to the method of analysis, whereby occurrence was estimated from the integrated RMS value of the signal, which more completely reflects the physiological correlates of motor unit behaviour during a

Table 4. The influence of gender and age on the jaw-jerk reflex variables (multiple regression statistical analysis): $\beta$ coefficient table

| | Standardized coefficient | | *t*-value | | Probability | |
|---|---|---|---|---|---|---|
| Variable | Gender | Age | Gender | Age | Gender | Age |
| Occurrence | | | | | | |
| At rest | 0.206 | −0.490 | 1.25 | 2.96 | 0.22 | 0.0064 |
| At clench | −0.353 | −0.326 | 2.06 | 1.90 | 0.05 | 0.07 |
| Latency | | | | | | |
| At rest | 0.415 | 0.449 | 2.46 | 2.66 | 0.02 | 0.01 |
| At clench | 0.583 | 0.269 | 3.85 | 1.78 | 0.0007 | 0.09 |
| Duration | | | | | | |
| At rest | −0.229 | −0.047 | 1.05 | 0.21 | 0.31 | 0.83 |
| At clench | −0.136 | −0.250 | 0.72 | 1.32 | 0.48 | 0.20 |
| Amplitude | | | | | | |
| At rest | −0.273 | −0.448 | 1.57 | 2.57 | 0.13 | 0.02 |
| At clench | −0.244 | −0.394 | 1.41 | 2.27 | 0.17 | 0.03 |

muscle contraction [31], rather than from the raw EMG.

## Particularities in jaw motor control system in the elderly

Age changes in muscular tissue differ according to their specific functional role. The elder jaw muscles present neither signs of atrophy nor a decrease in the population of type II fibres [23]. Habitual physical training facilitates protein retention and can delay the decrement in lean body mass and strength with ageing [20]. Since in healthy old subjects habitual oral motor movements (chewing, talking, swallowing) are maintained, muscular changes due to inactivity, as often happens in limb muscles, would not be expected. The participants were well adapted to their dentures; they were able to function adequately and protected their masseter muscles from disuse atrophy.

## Gender variation

Women's reflexes were consistently faster, except for the latency of the second phase of depression, and presented increased silent period duration. This differs from other limb stretch reflexes, which were consistently slower in women than in men [27]. Decline in performance seems to develop faster in later years for the older women, and at very old age women show very similar values to men. In their study on the Achilles tendon reflex, Milne and Williamson [16] recorded reduced occurrence of the reflex in women under 70 compared with men, but after that age the differences disappeared. Gender variation in muscular tissue [21, 22] and motor nerve conduction velocities [32] have been documented. Newton *et al.* [22] observed a greater decrease in cross-sectional area of the masseter and medial pterygoid muscles in edentulous men than in edentulous women. However, we are not aware of any gender variation in jaw reflex activity

Table 5. The influence of gender, age and silent period (SP) type on the SP variables (multiple regression statistical analysis): $\beta$ coefficient table

| | Standardized coefficient | | | *t*-value | | | Probability | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | Gender | Age | SP type | Gender | Age | SP type | Gender | Age | SP type |
| Latency | | | | | | | | | |
| Early SP | 0.57 | 0.11 | | 3.58 | 0.71 | | 0.001 | 0.49 | |
| Second phase of depression | 0.23 | −0.17 | −0.25 | 1.77 | 1.27 | 1.89 | 0.08 | 0.21 | 0.06 |
| Duration | | | | | | | | | |
| Early SP | 0.31 | −0.15 | −0.32 | 3.11 | 1.54 | 3.27 | 0.003 | 0.13 | 0.002 |
| Total SP | 0.29 | −0.17 | 0.25 | 2.83 | 1.63 | 2.52 | 0.006 | 0.11 | 0.01 |

after age 90 or of a reversed performance, with men performing better than women.

### Clinical significance of our findings

The functional significance of the age-related decrement in masseteric stretch reflex activity is uncertain. The only stretches applied to the masseter are from the mass of the mandible and the gravitational forces acting during walking, jumping or running [33]; the reflex has a substantial contribution to the jaw's postural stability during locomotion [34]. The lack of stretch reflexes decreases the rapid balance correction mechanisms [28]. However, movements that involve high acceleration in the vertical plane are not usually among the daily activities performed by very old people, thus the functional significance of a weak masseteric phasic stretch reflex response might not be important. During clenching, no age changes were observed. Sensory input from the muscle spindles is important in mastication: during jaw closure, when a change in the hardness of food is met, feedback from the muscle spindles enables corrective adjustments in the motor contraction pattern [34, 35]. The action of the stretch reflex during mastication is protected and maintained throughout the human life span.

The consistent presence of the silent period is indicative of its particular functional (protective) importance. It probably plays an important role in the neuromuscular control of mastication by preventing intra-oral damage, and in jaw movements during speech [7, 35, 36].

## Key points

- Masseteric reflex activity is maintained until very old age, particularly when elicited during contraction of the jaw elevators.
- At younger ages, the jaw-jerk reflex was maintained better in women but from middle age onwards their performance declines more steeply, particularly at rest.
- Jaw muscles do not show the age-associated changes found in many other muscles as healthy old people continue to use them for chewing, swallowing and talking.

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A pensioner who has dementia with a member of staff at a London day centre. © Sam Tanner.