

Age Related Changes of Superior Orbicularis Oris Muscle in Terms of Tone and Viscoelastic Properties

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Objective: To examine the age-related changes in the viscoelastic properties and tone of the superior orbicularis oris muscle by a portable hand-held myotonometer.

Methods: A total of 128 individuals (65 female, 63 male) who met the inclusion criteria were evaluated. Individuals were divided into 2 groups as under 40 years old (Group 1), and above (Group 2). The viscoelastic properties and muscle tone of orbicularis oris muscle were evaluated bilaterally in supine position with the Myoton PRO (Myoton AS, Estonia) device from the skin overlying the orbicularis oris. The reference point is accepted as the right and left paramedial philtrum dimple. The statistical analysis was performed.

Results: There was no statistically significant difference in the elasticity values of the right and left orbicularis oris muscles of the Group 1 and Group 2 individuals. There was a difference between the groups when the tone and stiffness values of both groups were compared. It was determined that individuals over the age of 40 had higher muscle tone and stiffness. All mechanical properties of the superior orbicularis oris muscle between the male and female individuals in Group 1 were different. The values are higher in the female gender. The elasticity values in both genders in Group 2 were similar. Tone and stiffness parameters were different between genders.

Conclusions: Myoton PRO can be recommended as an alternative device in the quantitative evaluations of post-operative follow-ups, and pre/post rehabilitation in terms of viscoelastic parameters of the muscle.

Key Words: Age factors, muscle tone, superior orbicularis oris, viscoelastic properties

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The orbicularis oris muscle is a multilayered muscle and located in the mouth region. It acts as a link for the facial muscles which are connected to the dermis of the upper and lower lip by a thin, superficial musculoaponeurotic junction.¹ Although the muscle acts independently, it is also seen that it moves together with the other facial muscles.² The muscle has deep and superficial fibers. Deep fibers of muscle perform general sphincteric activities that allow the mouth to close tightly and retain the food. Superficial fibers contribute to facial expressions and mimics during speech.³ The orbicularis oris muscle plays role in vital functions such as swallowing, chewing, and sucking, as well as in the formation of speech by applying pressure to the dental arch.^{4,5,6} In an ultrasonographic study, it was stated that muscle mass and muscle strength decreased by approximately 15% with increasing age and inactivity.⁷ In another study, less masseter muscle thickness in adults against young people was associated with decreased muscle functions in the head and neck region.⁸ If we think of the body as a whole, the conditions of the muscles can affect others. In a study by Raadsheer et al, which investigate the temporalis, pterygoideus lateralis, and pterygoideus medialis muscles, it was found that appendicular muscle thickness was greater in adolescents than the adult group. They also stated that this situation may be related to the decrease in metabolism or hormone secretion in adulthood.⁹ It has been reported that muscle atrophy and muscle fiber changes by aging decrease muscle tone in facial muscles. However, muscle stiffness increases by the increase of connective tissue and the accumulation of fat cells.^{10,11} Muscle stiffness of orofacial muscles increases with the increasing age in healthy individuals.¹² In a study in which temporalis and masseter muscles were evaluated with electromagnetic imaging, it was stated that the tone activity was controlled by sensory receptors and the central nervous system. It was emphasized that changes occur in these structures by aging and tone decreases.¹³ The effectiveness of this muscle in speech, nutrition, and swallowing functions has also been reported in various studies.^{14,15} Based on all this information, changes in the musculoskeletal system are inevitable with increasing age. However, studies in the literature on viscoelastic and tone properties of orbicularis oris muscle are rare. Also, there is no study done with Myoton PRO (Myoton AS, Estonia) device. Therefore, in this study we examine the age-related changes in the viscoelastic properties and tone of the muscle.

MATERIALS AND METHODS

Participants and Study Design

This cross-sectional study was conducted on 161 randomly selected volunteers, aged 18 to 68 years old, from Hasan Kalyoncu University students and faculty members. A total of 128 individuals (65 female, 63 male) who met the inclusion criteria were evaluated. Individuals were divided into 2 groups as under 40 years old (Group 1), and above (Group 2). The study was conducted between December 2020 and May 2021.

Inclusion and Exclusion Criteria

Voluntary individuals over the age of 18 years, without tooth deficiency, neurogenic swallowing and speech disorder, facial

paralysis, Covid-19 history, or symptoms were included in the study. Individuals with a body mass index of $\geq 30 \text{ kg/m}^2$, women in the menstrual cycle, pregnant, individuals who had botox history from face in last 1 year, and those who use muscle relaxant drugs were not included in the study.

Measurement Tool and Procedure

The physical characteristics and demographic information of individuals were noted before the test. Chewing side preference was determined by asking the subjects whether their preferred chewing side was right, left, or mixed.¹⁶ The viscoelastic properties and muscle tone of orbicularis oris muscle were evaluated bilaterally in supine position with the Myoton PRO (Myoton AS, Estonia) device from the skin overlying the orbicularis oris as shown in Figure 1B.

The mean value was calculated after 3 consecutive measurements were obtained at the measurement site for each parameter. The reference point is accepted as the right and left paramedial philtrum dimple as showed in Figure 1A.² The examiner marked the orbicularis oris superior muscle with a small ink dot. The measurement was repeated during a resting position.

The Myoton PRO device is one of the non-invasive, portable-hand-held myotonometer which is available to evaluate the tonus and viscoelastic properties of orofacial muscles.¹⁷ When the device is placed vertically on the muscle, the probe (3-mm diameter) creates constant preexcitations (0.18 N) and generates short-term (15 ms), low-force (0.4 N) mechanical stimulations. These stimulations induce natural oscillations in the tissue. The device records these oscillations with an accelerometer. Muscle tone, elasticity, and stiffness are calculated. Oscillation frequency (Hz) refers to the resting tone of a muscle, stiffness (N/m) is a biomechanical feature of the muscle that characterizes its resistance to a contraction or an external force. Elasticity is measured as a logarithmic reduction of the natural oscillations in the tissue.^{18,19} The objective measurement of muscle viscoelastic properties with Myoton PRO has a high test-retest reliability (intra-rater reliability range .84-.99; inter-reliability range .75-.96).²⁰

Ethical Approval

Ethical approval was obtained from the ethical committee of Hasan Kalyoncu University (ethics committee decision No: 2020/102, date of approval: 16.12.2020). The individuals were informed about the purpose and content of the study. Informed consent has been obtained from all individuals included in this study.

Data Analysis

The effect size for the study was estimated based on the previously published study.²¹ To find statistically significant difference between

age groups in terms of superior orbicularis oris tone measurement with big effect size (Cohen $d = 0.75$), the minimum required sample size for each group was estimated as 29 ($\alpha = 0.05$, $1 - \beta = 0.80$). Gpower package version 3.1.9 (Heinrich Heine University, Germany) was used for power analysis. SPSS 22.0 version (IBM; Armonk, NY, USA) version program was used to analyze the data. The normal distribution of data was determined by the Shapiro–Wilk test. Mann–Whitney U test was used to compare the non-normally distributed data between 2 groups, and the Independent Sample t test was used to compare the normally distributed data. Categorical variables were compared with the chi-square test. The value of $P < 0.05$ was considered as significant.

RESULTS

The mean age of all individuals was 32.15 ± 13.64 years. Sixty five (50.78%) of the participants were female. One hundred twenty one of the participants (94.5%) consisted of individuals whose chewing side preference is the right side. The characteristics of participants are given in Supplementary Digital Content, Table 1, <http://links.lww.com/SCS/D4>.

As shown in Supplementary Digital Content, Table 2, <http://links.lww.com/SCS/D4> there was no statistically significant difference in the elasticity values of the right and left orbicularis oris muscles of the Group 1 and Group 2 individuals ($P > 0.05$). There was a difference between the groups when the tone and stiffness values of both groups were compared ($P = 0.001$). It was determined that individuals over the age of 40 had higher muscle tone and stiffness.

It was determined that all mechanical properties of the superior orbicularis oris muscle between the male and female individuals in Group 1 were different. The values are higher in the female gender ($P < 0.05$). The elasticity values in both genders in Group 2 were similar ($P > 0.05$). However, a difference between genders was determined in tone and stiffness parameters ($P < 0.05$). Group comparisons in terms of mechanical properties and tone according to the gender are shown as in Supplementary Digital Content, Table 3, <http://links.lww.com/SCS/D4>.

DISCUSSION

In our study, in which we examined the age-related tone and viscoelastic properties of the superior orbicularis oris muscle with the Myoton PRO device, an increase in tone and stiffness of the muscle by aging, but lack of age-related elasticity change in the muscle, higher stated muscle tone and muscle stiffness in female gender are the major findings of our study.

Age-related muscle structure and functional changes are important parameters for many disciplines. Bennett et al¹¹ stated that changes occur by aging in the acoustic and kinematic measurements of speech. Dietsch et al¹² observed higher stiffness in the elderly group of their study, which evaluated the masseter muscle, cheek, and lateral tongue stiffness in young and old people. Perkisas et al found that the size and number of muscle fibers decrease with the increase of fibrous components in muscles with increasing age. Perkisas et al found that the size and the number of muscle fibers decrease with the increase of fibrous components by aging. They stated that muscle stiffness increase with the decrease in contractile tissue percentages.²² Studies have shown that a decrease in the tissue thickness by aging of facial muscles may be a result of changes in the subcutaneous and adipose tissue distribution.^{23–25} In our study, we found that the stiffness of the superior orbicularis oris muscle increased by aging. In the light of the literature, we think that the stiffness that increases with age is caused by many changes affecting the tissue.

Kocur et al²¹ stated that the tone of the upper trapezius and sternocleidomastoid muscles show an increase with increasing age,

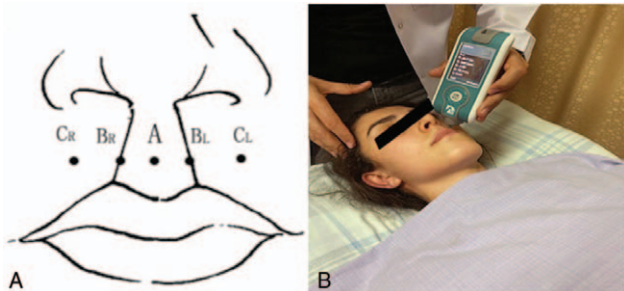


FIGURE 1. (A) A point: Philtrum dimple; BL, BR points: Philtrum columns; CL, CR points: Paramedial philtrum dimple (1 cm).² (B) Evaluation of the mechanical properties of superior orbicularis oris muscle.

and they added that this may occur by the structural remodeling in the myofascial tissue. Agyapong-Badu et al²⁶ evaluated the tone and viscoelastic properties of the biceps brachii and rectus femoris muscles in the resting position of the extremities and stated that the muscle tone increased with the increase in age. Our findings are consistent with the literature. We think that the increase in tone by aging may be related to the changes in myofascial tissue and passive contractile elements.

Wang et al²⁷ examined the knee extensors in men and women by free oscillation technique, and they reported that the muscle stiffness was higher in men. However, in another study in which Eby et al²⁸ evaluated the knee extensors by shear wave elastography, the stiffness was found higher in women. There are also studies in the literature indicating that the differences between genders may be related to fatigue, muscle fiber, muscle strength, and neural activation.^{29,30} In a study in which Kim et al³¹ evaluated the effect of gender and age on postural control, it was stated that the center of pressure increased in women with the increase in age. Tecco et al³² emphasized the importance of the stomatognathic system in maintaining balance and suggested that dental occlusion can regulate the body posture, and postural control. The higher scores of the muscle stiffness and tone parameters in women are due to the negative physiological changes in the muscle with the increase of age. These changes may cause a decrease in balance and postural control, and women are more affected by these changes against men.^{31,32} As a result, when we consider the body as a whole, we think that the stomatognathic system may be more activated in women as a compensatory mechanism, and consequently, it may be effective in increasing the tone and stiffness of the superior orbicularis oris muscle.

Akagi et al evaluated the age-related changes in muscle elasticity, and they sometimes stated that the elasticity of gastrocnemius and soleus muscles showed a decrease by aging, but sometimes unchanged. They concluded that this is a muscle-specific situation.³³ Studies in the literature emphasized that there is an inconsistency in age-related changes in muscle elasticity, so it can be said that chronological age may be a weak indicator.^{34,35} Similarly, Domire et al³⁶ reported the changes in age and muscle elasticity should not be associated with each other. In women, muscle tendons are weak and loose when compared to men, and this provides women higher elasticity and joint mobility.³⁷ In our study, the elasticity of the superior orbicularis oris muscle did not change with the increase in age. Elasticity was found to be higher in women under 40 years of age. In the light of the literature, the reason for the absence of age-related changes in muscle elasticity may be the different functional characteristics of the muscles. The higher elasticity in women under the age of 40 may be due to differences in the musculoskeletal system between females and males.

Reconstruction surgeries are performed on the orbicularis oris muscle for cosmetic or functional reasons. There are studies in which the orbicularis oris muscle thickness and functionality are followed by ultrasound and electromyography before and after the cleft palate and cleft lip surgeries. In cleft lip and philtrum reconstructions, adhesions may occur after the incisions in the orbicularis oris muscle.^{38,39} Studies stating that the orbicularis oris muscle is an important muscle for oral perception in mouth rehabilitation and swallowing rehabilitation.^{4,15} All surgical approaches disrupt the holistic structure of the orbicularis oris muscle fibers. In addition to the changes in the thickness of the muscle, incisions may also cause changes in the elasticity, tone, and stiffness of the muscle fibers. Myoton PRO can be recommended as an alternative device in the quantitative evaluations of postoperative follow-ups, and pre/post-rehabilitation in terms of viscoelastic parameters of the muscle.

All the participants came from the same university, and this sample selection from the same participant pool was the limitation

of our study. Another limitation is that some situations in the inclusion and exclusion criteria are assumed to be true based on personal statements.

In conclusion, we believe that the data obtained in this study may assist clinicians in evaluating the treatment of pathological conditions related to the superior orbicularis oris muscle, and in the planning of treatment as pre- and post-operational evaluations. In future studies, ultrasonographic and electromyography evaluations can be combined with the Myoton PRO device evaluations.

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