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Effect of Gum-Chewing on Facial Appearance and Stomatognathic System

Joo-Hwan Kim, Hae-Seo Park, Moon-Young Kim, Kyung-Wook Kim

Department of Oral and Maxillofacial Surgery, College of Dentistry, Dankook University, Cheonan, Korea

Purpose: This study was planned to clarify a negative view of chewing gum due to the concern that continuous gum chewing might cause a change in the gonial angle and make the lower facial appearance look square.
Materials and Methods: We had 25 adults (13 males and 12 females, with an average of 27.3 years) chew 6 g of gum (spearmint) evenly with both right and left posterior teeth for one hour per day for three months. We then measured their gonial angle, the inclination of occlusal plane, facial height, bone marrow density, and masticatory force before chewing, 1, 2, and 3 month after chewing to verify its significance statistically.
Result: The results showed that the gonial angle increased from 122.7° to 123.3° ($P>0.05$), and thus the jaws became slightly slimmer. There was no change in the occlusal plane inclination and facial height. Meanwhile bone marrow density in the mandibular angle and ascending ramus increased from 0.285 g/cm^2 to 0.290 g/cm^2 ($P<0.05$), and masticatory force also increased by 0.5 kg on the right side and 0.8 kg on the left side ($P<0.05$).
Conclusion: Continuous chewing of gum gives an appropriate exercise effect to the stomatognathic system. As chewing gum has effect on increase bone marrow density without changing the mandibular angle and facial appearance the claim that jaw bone changes to a square jaw through chewing gum is regarded to be groundless.

Key Words: Cephalometric analysis; Chewing gum; Facial appearance; Gonial angle

Introduction

Gum is an indulgence food that is easy to get and commonly used by modern people. Although gum was once just an indulgence food with sweeteners, now, through research and the efforts of manufacturers to meet the different needs of consumers, the types and utilization of gum has become more various: for the purpose of oral hygiene, removal of bad breath, and exercising of the stomatognathic system. The first gum in literature is chicle, which comes from the latex of sapodilla

Corresponding Author: **Kyung-Wook Kim**
Department of Oral and Maxillofacial Surgery, College of Dentistry, Dankook University, 119 Dandae-ro, Dongnam-gu, Cheonan 330-714, Korea
TEL : +82-41-550-1994, FAX : +82-41-551-8988, E-mail : kkwoms@dku.edu

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trees and was chewed by the ancient Mayans of Mexico from the 2nd century AD. Around 1860, the American Thomas Adams made the current form of gum by adding spices and sugar to the chicle. And William Wrigley made a large contribution to the expansion of the early gum market by creating bubble gum in 1890. After that, gum manufacturing technology grew more and more, and now gum is one of the most popular indulgence foods[1].

Past researchers said continuous masticatory movement through gum had a lot of influence on the stomatognathic system, on muscle appearance in particular, and caused an increase in occlusal force. Imfeld[1] said 560,000 tons of gum was produced annually all over the world, and if each stick of gum was chewed for about 30 minutes, humans have been chewing gum for 187 billion hours a year. Farella et al.[2] reported that chewing gum promoted oral hygiene through salivation, delivered various other medicines, and helped the jawbone exercise. Also, Farella et al.[3] described the influence of chewing gum on the cardiovascular system in another study. And Loginova et al.[4] found that chewing gum enhanced periodontal tissues by increasing blood circulation in periodontal tissues. There was also a study on using electromyography to show the influence of chewing gum on various masticatory muscles, and, based on a study using gum, Karkazis and Kossioni[5] reported that the food properties influenced electromyogram during mastication, and that controlling the mastication rate could control the variation in food hardness. Also, in studies on the refreshing effect of chewing gum using a brainwave test, Morinushi et al.[6] and Kim[13] found that chewing gum without spices increased alpha and beta waves by, and with spices added to gum, theta waves increased additionally. Also, there was a study reported that chewing gum increased bone marrow density in the mandibular angle and so could be helpful in preventing osteoporosis of the jawbone.

However, in spite of the various advantages of chewing gum, there is also a negative view due to the concern that continuous chewing of gum might cause a change in the gonial angle and make the lower facial appearance look square. In modern times, when a balanced and overall small and slim oval face is the standard of beautiful face, if chewing gum could change the lower facial appearance into a square one, it could cause a lot of controversy.

Nowadays, osteoporosis is also becoming a common chronic disease among the elderly, and the pain and fractures caused by the disease are a main therapeutic target. The major reasons for osteoporosis are ageing and menopausal hormone decrease. The major treatment methods are female hormone therapy, an increase in calcium and vitamin D intake, quitting smoking, and weight-bearing exercises. Above all, appropriate weight-bearing exercise is the most important preventive factor. There is at this time not much research about bone marrow density measurement of the jawbone and alveolar bone. Therefore, this study was designed to encourage chewing gum as an appropriate weight-bearing exercise.

This experiment was carried out to study the influence of continuous chewing of gum on the stomatognathic system. Cephalometric X-rays were used to see the effect of chewing gum on the mandibular angle and facial appearance, and an occlusal force test was performed to investigate the increase of masticatory force. Also, bone marrow density was measured to see if there was a change in bone marrow density of the jaw bone by the continuous exercise of masticatory muscles.

Materials and Methods

1. Subjects of Study

The subjects were 13 male adults and 12 female adults who were whole body healthy, had no temporomandibular disorder history, and had normal function of the stomatognathic system (There were 13 males in their 20s, seven females in

their 20s, three females in their 30s, and two females in their 40s. The average age was 27.3 years).

2. Methods of Study

We had the experiment subjects chew 6 g of gum (spearmint) evenly with both right and left posterior teeth for one hour per day for three months, and then measured several items before chewing (T0), one month after chewing (T1), two months after chewing (T2) and three months after chewing (T3), and compared the changes and verified their significance (at Dankook University Hospital from August to November in 2013).

The occlusal force of the first molar was measured each time to see whether masticatory pressure was changed, bone marrow density tests were performed to observe the increase of bone marrow density in the alveolar bone and mandibular ascending ramus, and cephalometric X-rays were took to observe changes in the gonial angle, facial height, and the occlusal plane inclination.

1) Cephalometric X-ray Imaging

Cephalometric X-rays (Kodak 9000 3D; Kodak, Rochester, NY, USA) were took to observe changes in the gonial angle, facial height, and the occlusal plane inclination during the experiment period. The landmarks and measurement items used in the X-rays are as follows (Fig. 1).

(1) Landmarks

Na (nasion): The uppermost point of the frontonasal suture

Me (menton): The lowest point of the contour of the mandibular symphysis at the tip of the jaw

Or (orbitale): The lowest point of the orbit

Po (porion): The uppermost point of the external auditory canal

Ar (articulare): The cross point of the downward direction of the skull base and backward direction of the left and right subcondyle

Go (gonion): The backward lowest point of the mandibular angle

F-H plane: The line connecting the porion and orbitale

Occlusal plane: The plane connecting the midpoint of the incisal edge of the maxillary and mandibular central incisors, and the midpoint of the occlusal plane of the maxillary and mandibular first molars

(2) Measurement Items

Gonial angle: The angle formed by Ar-Go and Go-Me was measured. As the angle increases the mandibular angle appearance gets slimmer, and as the angle is reduced, the jaw nears a square.

Occlusal plane inclination: The angle formed by the F-H plane and the occlusal plane was measured to grasp changes in the occlusal pattern and the mandibular inclination.

Facial height: The distance between Na and Me was measured to observe changes in the vertical length of the face.

2) Bone Marrow Density Test

We had the research subjects lie comfortably on a bone densitometer (Hologic, Bedford, MA, USA) and turn their heads, and then measured their bone marrow density.

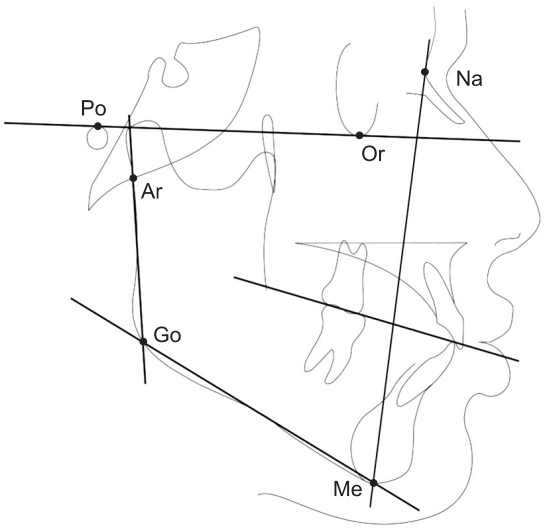

Fig. 1. Linear measurement and reference landmarks used in this study. Na: nasion, Po: porion, Or: orbitale, Ar: articulare, Go: gonion, Me: menton.

3) Measurement of Occlusal Force

We had the research subjects sit comfortably and measured the occlusal forces of the left and right first molars each time using an occlusal force gauge (FS-1020A; Fine Korea Co., Seoul, Korea).

3. Statistical Methods

For each measurement item, the average and standard deviation were calculated for each time and the difference was verified at a significance level of 0.05 (5%) by performing a Wilcoxon signed-rank test with PASW Statistics version 18.0 (IBM Co., Armonk, NY, USA) to evaluate their significance.

Result

1. Changes in Gonial Angle

The measured average angle of the mandibular angle area is as follows (Tables 1, 6). It increased by 0.3° from 122.7°±6.62° (before chewing) to 123.0° (one month after chewing). And it increased by 0.1° to 123.1° (two months after chewing) and finally by 0.2° to 123.3° (three months after chewing). There was no statistically significant change ($P<0.05$; Fig. 2, Table 6).

2. Changes in Occlusal Plane Inclination

The measured average occlusal plane inclination is as follows (Tables 2, 6). It decreased by 0.2° from

Table 1. Mean of gonial angle

	T0	T1	T2	T3
Degree (°)	122.7±6.62	123.0±6.41	123.1±7.01	123.3±7.11

T0: before chewing gum, T1: one month after chewing gum, T2: two months after chewing gum, T3: three months after chewing gum.

Values are presented as mean±standard deviation.

Table 2. Mean of occlusal plane inclination

	T0	T1	T2	T3
Degree (°)	26.7±4.84	26.5±4.28	26.4±5.21	26.5±4.80

T0: before chewing gum, T1: one month after chewing gum, T2: two months after chewing gum, T3: three months after chewing gum.

Values are presented as mean±standard deviation.

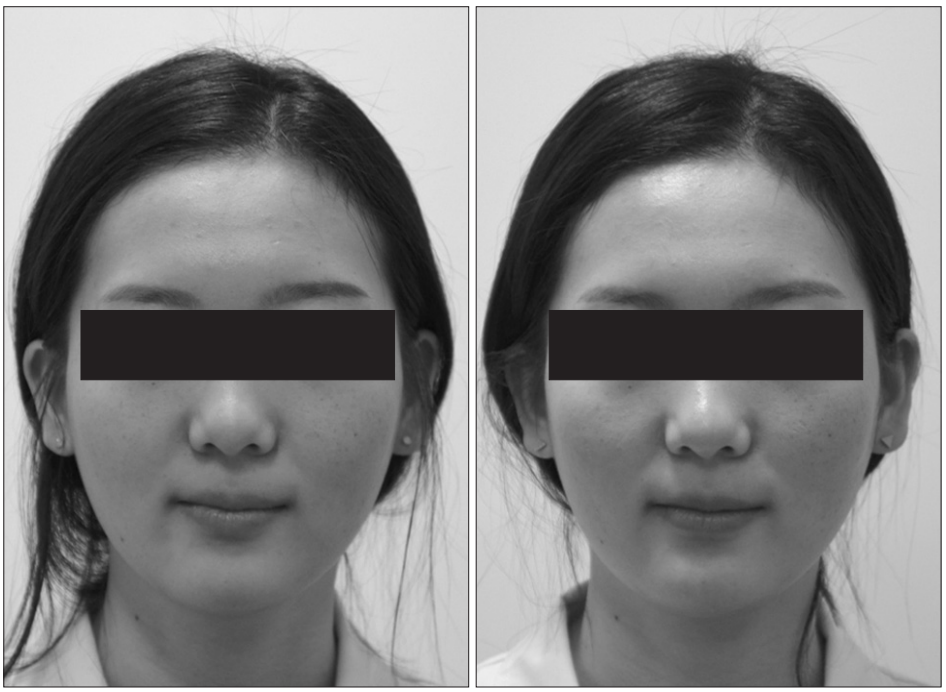

Fig. 2. Facial photos of T0, T3. T0: before chewing gum, T3: three months after chewing gum.

26.7° (before chewing) to 26.5° (one month after chewing). And it decreased by 0.1° to 26.4° (two months after chewing) and finally to 26.5° (three months after chewing). There were no statistically significant changes (P>0.05).

3. Changes in Facial Height

The measured average facial height is as follows (Tables 3, 6). It was 110.3 mm before chewing and 110.4±5.48 mm one month after chewing. It was also measured at 110.4 mm both two and three months later (P<0.05).

4. Changes in Bone Marrow Density

The measured average bone marrow density in the mandibular angle and ascending ramus is as follows (Tables 4, 6). It showed a significant change, by 0.002 g/cm^2 from 0.285 g/cm^2 (before chewing) to 0.287 g/cm^2 (one month after chewing) (P<0.05). Two months after chewing, there was no change, but it showed a significant change through an increase by 0.003 g/cm^2 to 0.290 g/cm^2 three months after chewing (P<0.05).

5. Changes in Occlusal Force

The measured left and right occlusal forces are as follows (Tables 5, 6). The right occlusal force increased by 0.5 kg, from 42.8 kg (before chewing) to 43.3 kg (three months after chewing), and the left occlusal force increased by 0.8 kg, from 36.2 kg (before chewing) to 37.0 kg (three months after chewing).

Table 3. Mean of facial height (mm)

	T0	T1	T2	T3
Length	110.3±5.53	110.4±5.48	110.4±5.33	110.4±5.41

T0: before chewing gum, T1: one month after chewing gum, T2: two months after chewing gum, T3: three months after chewing gum.
Values are presented as mean±standard deviation.

Table 5. Mean of occlusal force (kg)

	T0	T1	T2	T3
Right	42.8±11.12	43.0±13.32	43.0±12.25	43.3±13.33
Left	36.3±14.22	36.5±12.27	36.7±13.26	37.0 ±13.38

T0: before chewing gum, T1: one month after chewing gum, T2: two months after chewing gum, T3: three months after chewing gum.
Values are presented as mean±standard deviation.

Table 4. Mean of BMD (g/cm^2)

	T0	T1	T2	T3
BMD	0.285±0.021	0.287±0.024	0.287±0.028	0.290±0.029

T0: before chewing gum, T1: one month after chewing gum, T2: two months after chewing gum, T3: three months after chewing gum, BMD: bone marrow density.
Values are presented as mean±standard deviation.

Table 6. Test results by Wilcoxon signed-rank test

	T0~T1	T1~T2	T2~T3	T3~T0
Gonial angle				
Occlusal plane			*	
Facial height				
Bone marrow density	*		*	
Occlusal force		*	*	

T0: before chewing gum, T1: one month after chewing gum, T2: two months after chewing gum, T3: three months after chewing gum.
*Significant at a level of P<0.05.

Discussion

As a food-chewing action, mastication is a complicated physiological phenomenon and a harmonious functional system in which the whole stomatognathic system is involved. The functional units of mastication include the dentition, periodontal tissues, the jawbone, temporomandibular joint, muscles involved in mandibular movement, mouth and lips, tongue, cheek, salivary glands, and the nervous system.

Humans can feel the urge to chew something besides when eating and drinking. That is how the chicle obtained from sapodilla trees was born as a commodity, gum. The purposes of gum are various, from refreshing and the removal of bad breath to an increase in oral hygiene and the treatment of dentin hypersensitivity. And thanks to its advantage of being able to be used easily and simply, it can be a route for various medicines.

This experiment was planned to comprehensively consider the influence of continuous chewing of gum on the stomatognathic system. We measured the gonial angle, occlusal plane inclination, facial height, and bone marrow density to study the influence of chewing gum on the jawbone, and measured the masticatory pressure to see its influence on masticatory function.

The shape of the craniofacial skeleton is primarily decided by genes and secondly influenced by the local or whole body environment during growth. Muscles cause changes to skeletal form by giving physiological and mechanical effects to the skeleton. The occlusal force generated by the contraction of masticatory muscles is distributed through the teeth in the craniofacial skeleton and makes a stress line that forms an arrangement of bony trabeculae in the best direction for resistance to pressure. Therefore, the skeleton grows through complementary bone infiltration and resorption processes that are influenced by muscles. If the direction and magnitude of force are changed, the arrangement and pattern of bony trabeculae are also changed. This causes changes in bone infiltration and resorption processes, and a change in skeletal appearance[6].

Young people in our modern times prefer an oval face that has a large angle of the mandibular angle area. That is why many young women undergo plastic surgery to make their faces oval by removing the bone in the mandibular angle. One of the reasons many teenagers avoid chewing gum is a concern that they might have an angular lower facial appearance through a reduction of the angle in the mandibular angle area.

In this experiment, the gonial angle increased from 122.7° (before chewing) to 123.3° as the test subjects continued to chew gum, although there was no statistical significance ($P>0.05$). Therefore, even when a slight amount of error in cephalometric X-ray imaging and tracing is considered, the results of this research break down the myth that chewing gum makes a square jaw by decreasing the gonial angle. On the contrary, it presents the possibility of an oval face that has a bigger gonial angle. Also, the occlusal plane inclination and facial height did not change despite continuous chewing of gum.

In modern times, osteoporosis is becoming a serious social problem. If an early diagnosis for osteoporosis is appropriately made, the loss of bone marrow density can be prevented through appropriate weight-bearing exercises. Exercise plays an important role in making and maintaining strong bones, and stretching muscles can increase bone marrow density by stimulating bones. Exercise is a necessary factor for the prevention and treatment of osteoporosis, and in particular, exercises against gravity, in other words, weight-bearing exercises, are useful to prevent osteoporosis. Parhampour et al.[7] announced that weight-bearing exercises improved bone construction. The muscles in the maxillofacial region are difficult to use in weight-bearing exercises due to their nature, and chewing gum is regarded to be the most effective jawbone

exercise. Therefore, this study was designed to verify such.

Li et al.[8] said bone marrow density, thickness of muscles, and the force generated by muscles should be comprehensively evaluated to evaluate the strength of bones. Calbet et al.[9] said people who played soccer for a long time showed an increased bone marrow density in the thighbone and lumbar spine in an experiment targeting soccer players, and Hart et al.[10] found that bone construction and strength increased in mice that were trained by swimming. In this experiment, bone marrow density was increased by a certain amount in both the mandibular angle and ascending ramus. This bone marrow density increase was shown in the posterior area of the jawbone and ascending ramus where pressure was generated by continuous masticatory movement. An increase in blood circulation in periodontal tissues by mastication that was discovered by Loginova et al.[4] is regarded to be closely related to an increase in bone marrow density.

In this experiment, we had the research subjects carry out continuous jawbone exercises by chewing the gum one hour per day for three months, and bone marrow density in the mandibular angle and ascending ramus showed a statistically significant increase ($P<0.05$). According to the results of this experiment, continuous chewing of gum is regarded to be helpful in improving bone marrow density in the jawbone and is expected to play a big role in lowering the frequency of occurrence of jawbone osteoporosis in menopausal women.

There was a statistically significant increase in occlusal force by chewing gum ($P<0.05$). For the subjects of this experiment, more people chewed unilaterally on the right side than on the left side. This unilateral chewing habit is regarded to be an important reason for the high occlusal force on right posterior teeth in the results of the experiment. Deniz and Kulak Ozkan[11] announced that chewing gum activated the function of the masseter and anterior temporal muscles, and Hosman and Naeije[12] said that electromyogram activity was proportional to 80% of muscle strength in their experiment's electromyogram test in maximum mastication. The increase of in occlusal force in this experiment can be interpreted as an increase in masticatory muscle strength. Considering the experiment period was three months, the enhancement of masticatory muscle strength in this experiment could be regarded to be due to nerve transmission changes caused by repeated mastication rather than an increase in muscle size by in increase of muscular fibers. Additional research will be needed to verify the more accurate increase of muscular fibers.

Gum is one of the oldest indulgence foods humans enjoy, and almost the only method of the stomatognathic system exercise. This experiment showed that chewing gum for an appropriate amount of time helped the enhancement of the masticatory muscles, refreshing and relaxation, dispelled the myth that chewing gum makes the mandibular angle smaller and the jawbone more square, and had a positive influence on periodontal tissues and masticatory muscle exercise through an increase in bone marrow density.

Conclusion

This study was performed over three months with 25 male and female adult subjects to see if continuous chewing of gum changes the gonial angle, occlusal plane, facial height, bone marrow density and occlusal force. Through this study, the following results were obtained.

1. The measured gonial angle increased from 122.7° (before chewing) to 123.1° (one month after chewing). And it increased by 0.1° to 123.1° (two months after chewing) and by 0.2° finally to 123.3° (three months after chewing) gradually. But there was no statistically significant change ($P<0.05$).

2. The measured occlusal plane inclination decreased by 0.2° from 26.7° (before chewing) to 26.5°

(one month after chewing) and by 0.1° to 26.4° (two months after chewing) and finally to 26.5° (three months after chewing). There was no statistically significant change (P>0.05).

3. The measured facial length was 110.3 mm before chewing and 110.4 mm one month after chewing. And it was measured as 110.4 mm both two months later and three months later (P<0.05).

4. The measured bone marrow density in the mandibular angle and ascending ramus showed a significant change by increasing by 0.005 g/cm^2 from 0.285 g/cm^2 (before chewing) to 0.290 g/cm^2 (three months after chewing) (P<0.05).

5. The measured right occlusal force increased by 0.5 kg from 42.8 kg (before chewing) to 43.3 kg (three months after chewing), and the left occlusal force increased by 0.8 kg from 36.2 kg (before chewing) to 37.0 kg (three months after chewing). These were statistically significant results (P<0.05).

Putting the results of this research together, continuous chewing of gum gives an appropriate exercise effect to the stomatognathic system. This effect strengthens and activates masticatory muscles and thus increases occlusal force. Also, as chewing gum causes an increase in bone marrow density without changing the mandibular angle and facial bone, the claim that the jawbone changes to a square jaw through chewing gum is regarded to be groundless. Also, due to this increase in bone marrow density, chewing gum is considered to be very helpful in preventing osteoporosis in menopausal women.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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