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CLINICAL RESEARCH

Effect of transcutaneous electrical nerve stimulation (TENS) on the electromyographic activity of human masticatory muscles in young people with normal occlusion

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ABSTRACT

Statement of problem. Transcutaneous electrical nerve stimulation (TENS) has been used in several clinical areas. However, the effect of TENS on the masticatory muscles of young individuals with normal occlusion remains unclear.

Purpose. The purpose of the study was to assess the effect of TENS on the surface electromyographic (sEMG) activity of masticatory muscles in a young population with normal occlusion.

Material and methods. Twenty residents (5 men and 15 women, mean 24.27 ±2.59 years) of Dalian Stomatological Hospital were enrolled as the study participants. A trained operator collected the required information from the participants. The experiment was divided into 3 stages: pre-TENS acquisition, TENS application, and post-TENS acquisition. The pre-TENS stage was performed using surface electromyography (sEMG) (Myotronics Inc) to acquire the potential values of masticatory muscles in the following 3 states 5 times each: resting, intercuspal occlusion (ICO), and maximum voluntary clench (clenching). The potential values of the anterior of temporalis (TA), the masseter (MM), the sternocleidomastoid (SCM), and the anterior digastric (DA) muscles were collected in the resting state, and TA and MM were collected in the ICO and clenching states. During the TENS application phase, a TENS Unit device (J5 Myomonitor) (J5) was used on each participant for 45 minutes. The post-TENS acquisition phase involved the same procedure as the pre-TENS phase. The experimental data were recorded, and the normality of each group was analyzed using the Shapiro-Wilk test in a statistical software program (IBM SPSS Statistics, v26.0). The paired-sample *t* test was used to compare the differences in the mean values of sEMG and the asymmetry index (As); the independent-sample *t* test was used to compare the activity index (Ac) and torque index (To) (α=.05).

Results. Significant differences were observed in the mean potential values of TA, MM, LSCM, and RDA before and after TENS in the resting state and RTA, LMM, and RMM before and after TENS in the clenching state (P<.05). Moreover, although As_{DA} values showed a significant difference (P=.027) before and after TENS in the resting state, the differences in As values for the other muscles in the resting state were statistically similar. Furthermore, in each state, the mean values of Ac and To after TENS showed no significant differences before and after TENS (P>.05).

Conclusions. The resting EMG values of the TA and MM differed significantly before and after TENS. After TENS, the resting EMG activity decreased, whereas the functional EMG activity tended to increase. (J Prosthet Dent 2025;133:489-497)

The electromyographic (EMG) activity of masticatory muscles has been widely studied with both indwelling electrodes and surface recordings.[1,2] Currently available surface electromyography instruments allow an investigation of the EMG activity of muscles (typically temporalis anterior and posterior, masseter, digastric anterior, sternocleidomastoid) involved in mastication and swallowing and in head posture. The use of appropriate protocols enables good

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Clinical Implications

The resting EMG activity decreased, and the functional EMG activity tended to increase after TENS, supporting its use as a neuromuscular deprogramming tool. By relaxing the masticatory muscles and relieving symptoms associated with muscle spasm to contribute to the physiologic occlusion, TENS can be applied to prosthetic dentistry.

accuracy and reproducibility of the recorded measurements,[3,4] and EMG potentials have been combined with the assessment of muscle symmetry and different movement patterns.[5–7]

Transcutaneous electrical nerve stimulation (TENS) is a nonpharmacological treatment approach involving the application of electrical stimulation to primary nerves.[8] The parameters of the electrical stimulation (amplitude and pulse duration) are tailored according to the neurophysiological mechanisms at the different sites of action, thus achieving therapeutic goals. The term TENS has been typically used in the field of rehabilitation medicine to refer to analgesic TENS (for pain suppression). Based on the frequency, the stimulations have been classified into high-frequency (usually >50 Hz) and low-frequency (<10 Hz). In general medicine, TENS has been mainly used to relieve musculoskeletal pain. In dentistry, TENS refers to neuromuscular TENS (functional muscle stimulation), which is typically performed at an ultralow frequency (ULF) of <4 Hz, hence the name ULF-TENS.[8] The mechanism of the action of TENS has been categorized into 2 pathways: prograde pathway and retrograde pathway.[8] In the prograde pathway, the electrical impulse is conducted to the motor nerve trunk, and then the current is delivered to the peripheral nerves, thus passing through the muscle fibers innervated by that nerve trunk. This pathway causes the muscle to contract; moreover, if the amplitude of the stimulus is adequate to activate sufficient muscle fibers, the corresponding part of the body may be displaced if the area to which this muscle is attached is movable. Therefore, the effect of an electrical impulse on the fifth or seventh cranial nerve to the brain may cause a corresponding contractile activity in the mandible, lips, and eyelids. In the retrograde pathway, the electrical impulse is conducted to the motor nucleus of the target nerve, thereby activating the motor neuron and further transmitting the impulse directly to the muscle fibers. In both pathways, the electrical impulses from TENS excite the motor nerve fibers of the fifth pair of cerebral nerves, thereby inducing a rhythmic contraction of the corresponding muscle attachment site and causing relaxation of the masticatory muscles.[9–11] Cooper and Kleinberg[9] evaluated the effect of TENS on the electrical activity of masticatory muscles in participants with temporomandibular disorder (TMD) and concluded that the application of TENS for 60 minutes in participants with TMD led to relaxation of the masticatory muscles as evidenced by a decrease in their EMG potential values. Kamyszek et al[12] evaluated the effect of applying TENS for 30 to 40 minutes in participants with TMD with and without muscle tremor at rest, with the same decrease in EMG potential values noted. Their findings were consistent with those of Bazzotti.[13] Researchers have also used the asymmetry (As), torque (To), and activity (Ac) indices to assess EMG values.[14–16]

However, an accurate evaluation of the changes in the same parameters before and after TENS in a population with normal occlusion is currently lacking. Hence, the present study was to determine the effect of TENS on the EMG activity of masticatory muscles in a young population with normal occlusion. The null hypothesis was that TENS would not affect the EMG activity of the masticatory muscles in a young population with normal occlusion.

MATERIAL AND METHODS

Twenty residents (5 men and 15 women, mean 24.27 ±2.59 years) of the Dalian Stomatological Hospital were enrolled as the study participants. The inclusion criteria were 20 to 30 years old; individual normal occlusion (Class I or NEUTRO-OCCLUSION: the dental relationship in which there is normal anteroposterior relationship of the jaws, as indicated by intercuspal position of maxillary and mandibular molars[17]); facial symmetry; no history according to the diagnostic criteria for temporomandibular disorders (DC/TMD) or symptoms of TMD; normal type of opening, basically symmetrical bilateral condylar motion; no popping; no masticatory muscle tenderness; no chronic systemic diseases affecting the temporomandibular joints; no noxious habits such as nocturnal teeth grinding, clenching, and lateralized mastication; good periodontal health; no dental emergencies; no teeth with a mobility above 1 degree; no history of dental trauma; and good physical health with no systemic diseases.

The study was conducted in accordance with the 1975 Declaration of Helsinki as revised in 2013, and the study protocol was approved by the Ethics Committee of Dalian Stomatological Hospital (approval number: DLKQLL2022022). Signed informed consent was received from all recruited participants before the start of the study.

A trained operator (X.W.) collected information from the participants in the early morning. An 8-channel surface electromyography (Myotronics Inc) was used to record surface EMG values with 4.3×2.2-cm EMG electrode pads. Each of the 2 circular Ø1-cm conductive zones had an electrode spacing of 2 cm. The skin on the right and left sides of the anterior of the temporalis (TA), masseter (MM), sternocleidomastoid (SCM), and anterior of digastric (DA) were wiped with 75% alcohol cotton balls and dried, and the electrode pads were placed according to the direction of the muscle fibers to ensure bilateral symmetry. The system was then connected to the electrode pads, and the test was started 5 minutes after the connection.

The resting EMG potential activity of the 4 groups of muscles was recorded for 15 seconds, then a 3-minute rest, and the next test started. Five recordings were performed in this order, and the obtained data were saved (Fig. 1).

Next, the EMG potential values in the intercuspal occlusion (ICO) state were recorded. The participants were asked to occlude from the mandibular postural position (MPP), the position of the mandible when a person is comfortably resting and the associated muscles are in a state of minimal contractual activity,[17] to the intercuspal position (ICP) at the sixth second and to hold for 9 seconds. The recording was then stopped, and the participant asked to relax. After a 3-minute rest period, the next test was conducted. Five recordings were performed in this order, and the obtained data were saved (Fig. 2).

Lastly, the EMG potential values in the clenching state were recorded. After pressing the start button, the participant was asked to rest for 1 second and then to occlude with maximum force, holding this position for 2 seconds and then relaxing for 2 seconds. The participant was again asked to occlude with maximum force. After a 3-minute rest, the next test was started. The clenching state was recorded 5 times in this order, and the data were saved (Fig. 3).

The J5 is a kind of TENS device used for dentistry and has a digital electronic pulse generator specifically optimized for bilateral transcutaneous electrical neural stimulation of the stomatognathic system.[17] It has a frequency of <4 Hz and is a bilateral ULF-TENS specifically designed for the oromandibular system.

For TENS, the skin surface was wiped with a 75% alcohol cotton ball and dried, and the 4.0×3.8-cm electrode pads were then placed on the skin. Two electrodes were placed symmetrically above the skin projection of the mandibular sigmoid notch, and a third grounded electrode was placed in the center of the back of the neck. In the power-off mode, each knob of the TENS unit was set to zero, and the electrode wires were connected to the electrode pads. The system was switched on, and channel A was first adjusted by gradually observing until the participant's eyes closed rhythmically, ensuring consistent intensity from the left to right side. The adjustment was continued until the mandible was approximately 1 mm displaced, ensuring that the maxillary and mandibular teeth did not contact during this process. Channel B was opened similarly, and the upper trapezius muscle was determined to show a distinct and equal contraction. Counting was started, and adjustments to the amplitude and balance were

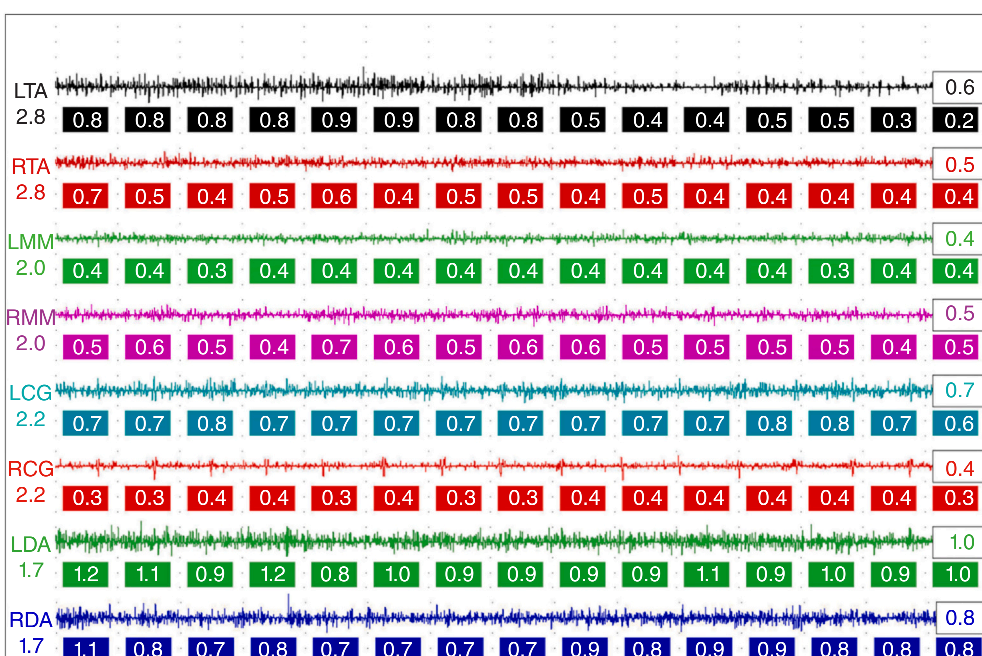

Figure 1. Electromyography of four pairs of muscles in resting state. LTA, left anterior temporalis; LMM, left masseter muscle; LCG, left cervical group muscle(refer to the sternocleidomastoid muscle in this experiment); LDA, left anterior of digastric; RTA, right anterior temporalis; RMM, right masseter muscle; RCG, right cervical group muscle (refers to the sternocleidomastoid muscle in this experiment); RDA, right anterior of digastric.

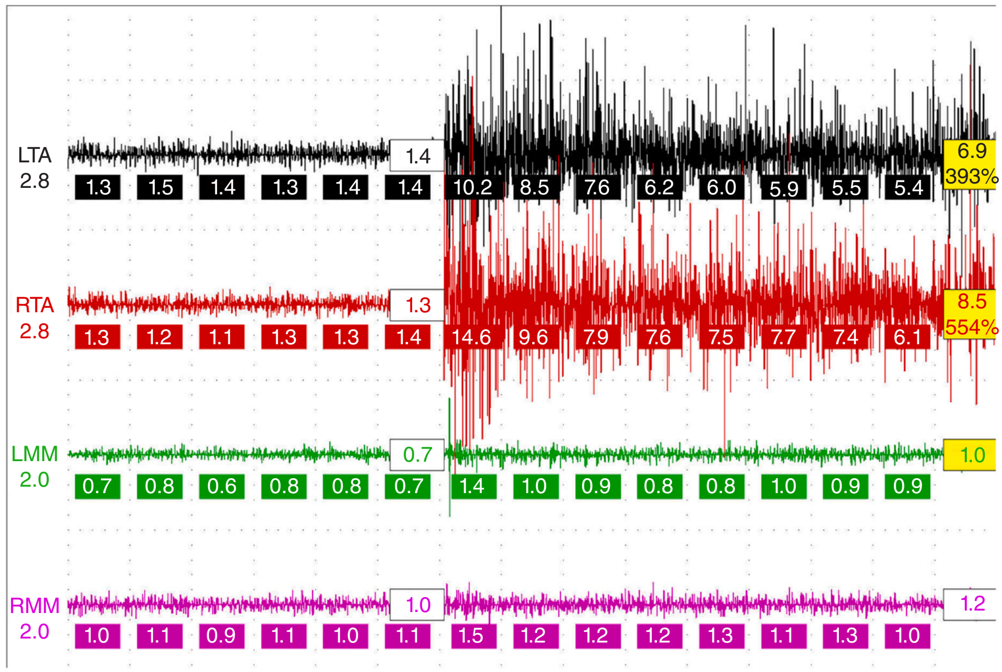

Figure 2. Electromyography of temporalis and masseter in intercuspal occlusion state. LTA: left anterior temporalis; LMM: left masseter muscle; RTA: right anterior temporalis; RMM: right masseter muscle.

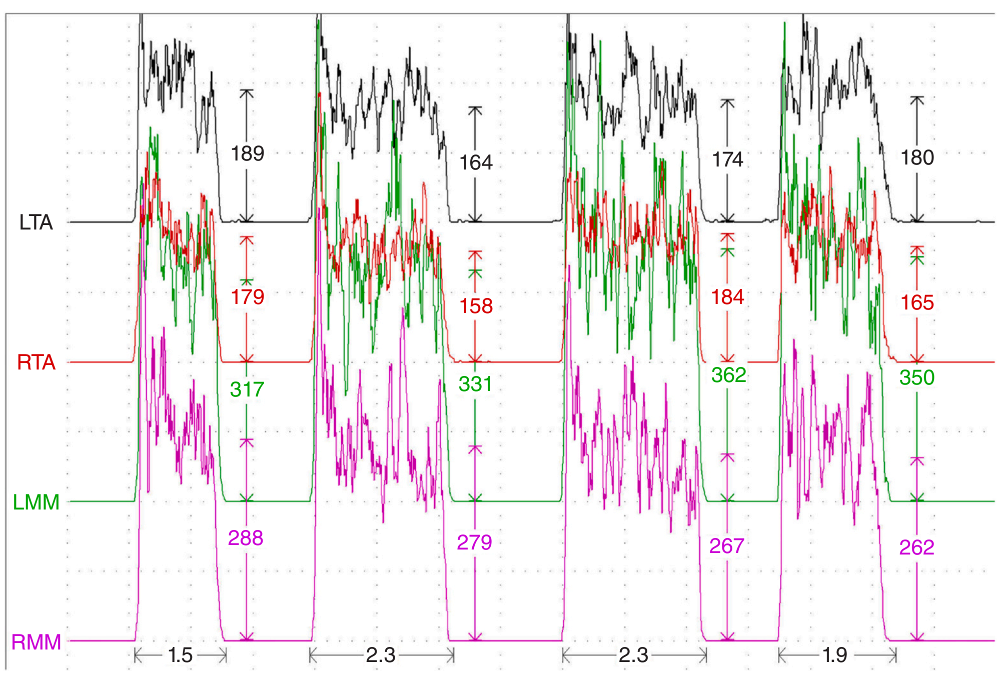

Figure 3. Electromyography of temporalis and masseter in clenching state. LTA, left anterior temporalis; LMM, left masseter muscle; RTA, right anterior temporalis; RMM, right masseter muscle.

made as necessary every 10 to 15 minutes. The process was stopped after 45 minutes. EMG values in the 3 states were measured again after TENS, and the average EMG values were calculated.

To quantify asymmetrical masticatory muscle activity, the As reported by Naeije et al[5] was calculated for each participant and for each muscle from the average MM and TA potentials recorded during each test (resting, ICO, and clenching) as follows:

$$As_{tot} = \left(\frac{MM_R + TA_R - MM_L - TA_L}{MM_R + TA_R + MM_L + TA_L}\right)\%$$

$$As_{TA} = \left(\frac{TA_R - TA_L}{TA_R + TA_L}\right)\%$$

$$As_{MM} = \left(\frac{MM_R - MM_L}{MM_R + MM_L}\right)\%$$

Because of the different directions of action of the temporalis and occlusal muscles, force couples were produced by the mandible.[14] If the bilateral force couples were unbalanced, they would bias the mandibular force to one side, that is, create a torque. To evaluate the presence of a resultant force couple, the To was calculated from the EMG averaged potentials recorded during each test as follows:

$$To_{tot} = \left(\frac{TA_R + MM_L - TA_L - MM_R}{TA_R + MM_L + TA_L + MM_R}\right)\%.$$

The relative contribution of MM and TA was compared by using the Ac introduced by Naeije et al.[5] This index was calculated from the averaged potentials recorded during each test as follows:

$$Ac_{tot} = \left(\frac{MM_R + MM_L - TA_R - TA_L}{MM_R + MM_L + TA_R + TA_L}\right)\%.$$

A statistical software program (IBM SPSS Statistics, v26.0; IBM Corp) was used for data analysis. The Shapiro-Wilk test was used to analyze the normality of the data in each group. Normally distributed data were expressed as mean and standard deviation. The paired-samples *t* test was used to compare the mean EMG values and As values before and after TENS; the independent-samples *t* test was used to compare Ac and To values (α=.05).

RESULTS

Twenty participants were recruited for this study, and the EMG values of different masticatory muscles in the resting, ICO, and clenching states were recorded. In the resting state, the differences between the mean EMG values of LTA, RTA, LMM, RMM, LSCM, and RDA after TENS and those of the corresponding muscles before TENS were statistically significantly different (P<.05); however, no significant differences were noted in the mean EMG values of RSCM and LDA before and after TENS (P>.05). The mean EMG values of all 4 muscle pairs decreased after TENS (Table 1).

The differences between the mean EMG values of LTR, RTA, LMM, and RMM before TENS and the mean EMG values of the same named muscle after TENS in the ICO state were statistically similar (P>.05) (Table 1). In the clenching state, the differences in the mean EMG values of LTR, RTA, LMM, and RMM before TENS and the mean EMG values of the same muscle type after TENS were significantly different (P<.05); however, the differences in the mean EMG values of LTA before and after TENS were statistically similar (P>.05). TA and MM showed an increase in the mean EMG values after TENS, and the increase in MM was greater than that in TA (Table 1).

Table 1. Mean and standard deviation of EMG values of four pairs of muscles before and after TENS

	Before TENS		After TENS		P
	Mean	sd	Mean	sd	
Resting					
LTA	1.30	0.66	0.81	0.40	<.001
RTA	1.31	0.56	0.94	0.43	.003
LMM	1.39	0.74	0.71	0.28	<.001
RMM	1.48	1.35	0.84	0.51	.007
LSCM	1.56	0.58	1.23	0.35	.018
RSCM	1.23	0.37	1.06	0.36	.080
LDA	2.62	2.63	1.53	0.84	.085
RDA	1.85	1.08	1.32	0.58	.025
ICO					
LTA	14.37	15.71	18.42	16.46	.080
RTA	10.03	10.97	13.27	9.21	.063
LMM	11.11	18.75	10.76	15.05	.816
RMM	11.96	20.84	13.54	19.44	.382
Clenching					
LTA	132.78	58.45	146.66	58.14	.053
RTA	114.62	45.97	129.40	42.56	.003
LMM	146.69	74.40	163.15	77.25	.025
RMM	149.57	81.95	166.97	76.01	.002

clenching, maximum voluntary clench; DA, anterior of digastric; EMG, surface electromyography; ICO, intercuspal occlusion; L, left; MM, masseter muscle; R, right; SCM, sternocleidomastoid muscle; sd, standard deviation; TA, anterior temporalis; TENS, transcutaneous electrical nerve stimulation.

As_{TA} and As_{MM} and the total asymmetry index (As_{tot}) were calculated by using the paired samples *t* test for each group of data before and after TENS. The As values showed no significant differences between before and after TENS (P>.05), except for the resting state in which the differences in As_{DA} were significantly different (P<.05). All 20 participants showed asymmetrical muscle activity both before and after TENS; As_{tot} decreased after TENS for all test states and for all tested muscles. The As values of the resting and ICO states were higher than those of the clenching state, both before and after TENS (Table 2).

To evaluate the presence of a resultant force couple, a To was calculated, consisting of 1 temporal muscle paired with the contralateral masseter muscle, that is, RTA and LMM (right side pair) and LTA and RMM (left side pair). If these 2 pairs of muscles were not balanced, their combined effect would cause the jaw to be biased toward the dominant side. To assess bias, the experimental data obtained before and after TENS were grouped according to the left and right pairs of muscles, and the independent samples *t* test was performed. No significant differences were noted between the data obtained before and after TENS for the left and right muscle pairs (P>.05) (Table 3).

For the Ac, a negative number indicated prevalent TA activity, and a positive number prevalent MM activity. The mean and standard deviation of positive (MM>TA)

Table 2. Mean and standard deviation of asymmetry index (As) of four pairs of muscles before and after TENS

	Before TENS		After TENS		P
	Mean	sd	Mean	sd	
Resting					
As_{TA}	17.94	15.50	18.96	13.79	.791
As_{MM}	21.62	25.47	18.22	17.00	.398
As_{tot}	17.65	16.90	14.98	11.86	.409
As_{SCM}	17.11	12.44	16.51	13.25	.855
As_{DA}	17.35	11.84	9.88	9.52	.027
ICO					
As_{TA}	27.49	18.27	25.45	17.92	.562
As_{MM}	17.76	13.75	19.26	15.00	.711
As_{tot}	18.71	10.56	17.43	13.37	.609
Clenching					
As_{TA}	9.02	9.81	7.75	7.39	.191
As_{MM}	10.19	7.06	8.10	6.20	.176
As_{tot}	6.19	2.61	4.66	3.00	.075

As, asymmetry index; clenching, maximum voluntary clench; DA, anterior of digastric; ICO, intercuspal occlusion; L, left; MM, masseter muscle; R, right; sd, standard deviation; SCM, sternocleidomastoid muscle; TA: anterior temporalis; TENS, transcutaneous electrical nerve stimulation.

and (TA>MM) values were calculated separately, and independent samples *t* tests were performed. The Ac values of each muscle before and after TENS were not significantly different (P>.05). In the resting state, most participants used MM to maintain jaw posture before TENS and mostly used TA to maintain jaw posture after TENS; Furthermore, only 5% of participants had no muscle bias during functional activity (Ac_{tot}=0) before and after TENS. The Ac_{TA} value was higher than the Ac_{MM} value before and after TENS (approximately 17% versus 13% before TENS and 15% versus 12% after TENS). In the ICO state, more than 80% of participants had a more active TA, with an Ac value of approximately 40% before TENS and 49% after TENS. In contrast, in the clenching state, MM was relatively active both before and after TENS, with Ac_{MM} being higher than Ac_{TA} in all situations (Table 4).

DISCUSSION

The null hypothesis that TENS would not affect the EMG activity of the masticatory muscles in a young population with normal occlusion was rejected based on the results of this study. The mean EMG values of all 4 muscle groups decreased with statistically significant differences in the resting state (P<.05).

The results were consistent with those reported in previous studies. Cooper and Kleinberg,[9] Kamyszek et al,[12] and Bazzotti[13] assessed the effects of TENS on the resting EMG values in participants with TMD and confirmed the relaxing effect of TENS on masticatory muscles; thus, EMG values decreased in the resting state. In the present study, in addition to the determination of potentials in the resting state, EMG values were also obtained in the ICO and clenching states; the results showed an increase in EMG values in both these state after TENS. No significant differences were noted in the EMG values of both TA and MM in the ICO state; however, a significant difference (P<.05) was observed in the EMG values in the clenching state (except for LTA). Based on these results, it appears that TENS not only relaxes the muscles and decreases the resting EMG values but also increases EMG values in the functional active state (ICO and clenching), consistent with Cooper and Kleinberg,[9] who compared the mean EMG values of the clenching state before and after TENS, reporting a significant difference (P<.001). The reason for differences with the present study may have been that the participants of Cooper and Kleinberg's study were people with symptomatic TMD, whose EMG showed high potentials at the resting state and low potentials during activity and that their EMG values changed substantially after receiving TENS, leading to a significant difference before and after TENS, In contrast, the participants of the present study had normal occlusion without symptoms of TMD.

To quantify the asymmetric activity of the masticatory muscles, Naeije et al[5] used the As values to assess the symmetry of the muscles. In the present study all 20 participants had asymmetric muscle activity both before and after TENS; and the mean value of asymmetry was higher for the resting and ICO states. The As_{tot} value decreased after TENS for each test state and for each tested muscle, thus indicating a trend toward more

Table 3. Mean and standard deviation of torque index (To) of anterior temporalis and masseter muscles before and after TENS

	n	Before TENS		n	After TENS		P
		Mean	sd		Mean	sd	
Resting							
L>R	11	13.95	11.58	10	16.51	10.92	.608
R>L	9	13.44	12.16	10	11.09	10.05	.651
ICO							
L>R	10	13.16	11.13	7	15.07	12.95	.749
R>L	10	22.05	14.84	13	17.34	11.47	.399
Clenching							
L>R	8	4.88	2.75	8	3.41	2.52	.283
R>L	12	10.64	7.49	12	8.52	7.29	.486

clenching, maximum voluntary clench; ICO, intercuspal occlusion; L, left; R, right; sd, standard deviation; TENS, transcutaneous electrical nerve stimulation.

Table 4. Mean and standard deviation of active index (Ac) of anterior temporalis and masseter muscles before and after TENS

	n	Before TENS		*n*	After TENS		*P*
		Mean	sd		Mean	sd	
Resting							
MM>TA	12	13.77	9.59	6	11.98	8.92	.708
TA>MM	7	17.40	6.83	13	15.77	12.65	.757
ICO							
MM>TA	3	46.69	29.95	4	38.32	26.65	.712
TA>MM	17	39.81	22.21	16	48.96	25.39	.279
Clenching							
MM>TA	13	14.50	11.95	13	13.18	10.11	.764
TA>MM	7	11.30	9.74	7	5.16	3.73	.146

clenching, maximum voluntary clench; ICO: intercuspal occlusion; MM: masseter muscle; sd: standard deviation; TA: anterior temporalis; TENS: transcutaneous electrical nerve stimulation.

symmetrical overall muscle symmetry in each state after TENS as compared with that before TENS. Interestingly, As_{tot} was smaller than As_{TA} and As_{MM} in the same state. Ferrario et al[14] suggested that this phenomenon was because of the presence of a compensating factor between the TA and MM, which neutralized the opposite effects of these muscles. The muscle fibers of the TA and MM are arranged in different directions, with the TA bundle acting upward and backward and the MM acting upward and forward (Figs. 4, 5).[7,18] This physiological difference also manifests itself as a pair of force couples which, if unbalanced bilaterally, cause the mandible to deflect to one side, inducing torque.

The To value calculated from the average EMG potential was used to assess the presence of this force couple.[14] A slight torque effect was present in all participants. The To value was maximum in the ICO state and minimum in the clenching state both before and after TENS. This might be because in the resting state, balance was achieved through the activity of other muscles, such as the posterior temporalis bundle, the internal pterygoid muscle, and the external pterygoid muscle,[19,20] whereas in the ICO and clenching states, a torque effect occurs because of the involvement of the teeth. Compared with the clenching state, the tooth contact in the ICO state is maintained in the absence of clenching forces and requires relative equilibrium maintained by the complex muscle activity, resulting in a larger To value for the ICO and a smaller one for the clenching state.

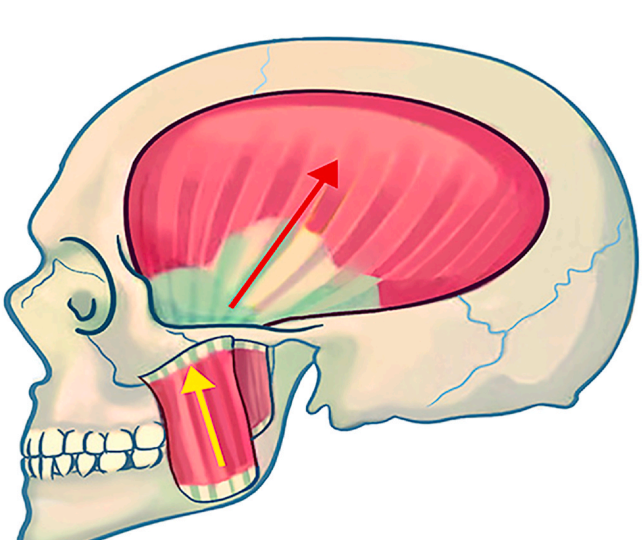

Figure 4. Schematic diagram of orientation of muscle fibers of temporalis and masseter. *Red arrow* indicates direction of contraction of temporalis muscle, *yellow arrow* indicates direction of contraction of masseter muscle.

The Ac value has been used to compare the relative contribution of the TA and MM. In a healthy adult population, the TA bundle primarily maintains the mandibular posture, along with the posterior temporalis bundle and other muscles,[21,22] with little reliance on the MM. In the present study, 60% of the participants used the occlusal muscles to maintain the mandibular posture before TENS, while only 30% of the participants used the occlusal muscles to maintain the mandibular posture after TENS; this finding indicated that most of the participants used the temporalis muscles to maintain the mandibular posture after TENS. The higher Ac value of the TA in the ICO state after TENS was consistent with the findings of McCarroll et al[15,16] and Naeije et al[5] that the temporalis muscle predominates at low contraction levels. The MM was relatively active in the clenching state, both before and after TENS, and its Ac value was higher than that of the temporalis muscle. This difference was because MM contributes more to the occlusal force with an increases in the occlusal force(approximately 14% versus 11% before TENS and 13% versus 5% after TENS).[14]

Limitations of the present study included the small sample size. Although the sample size met the requirements of the paired samples *t* test (validity=0.8, α=.05, β=.8, sample size=15), there was some convergence in the data. Moreover, although some of the findings were consistent with those of previous studies, these findings could not be generalized because of the small sample size. The lack of significant differences in some of the experimental data and the large fluctuations in the data might also be due to the small sample size.

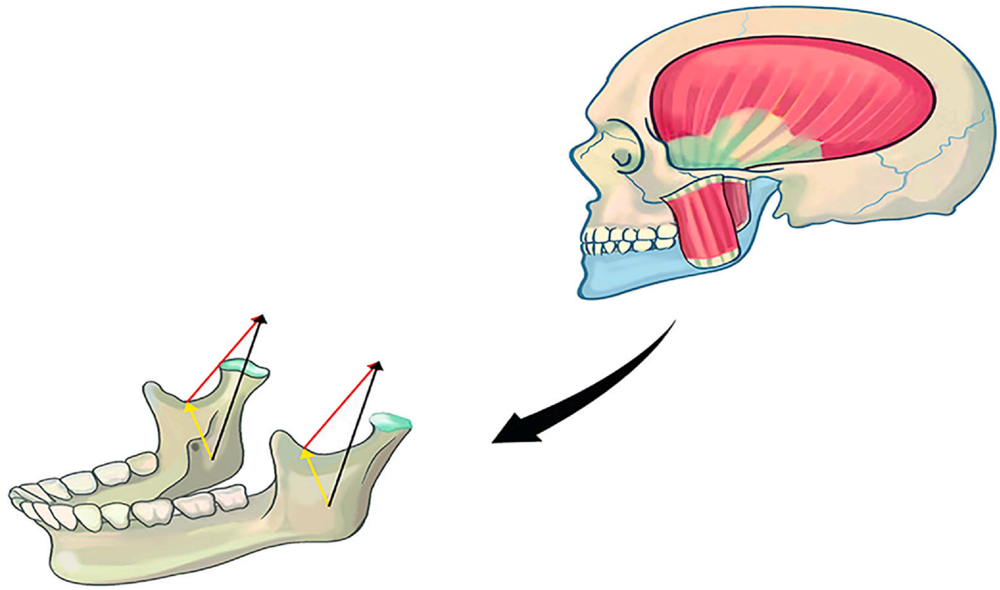

Figure 5. Schematic diagram of torque effect. *Red arrows* indicate direction of contraction of temporalis muscle, *yellow arrows* indicate direction of contraction of masseter muscle, and *black arrows* indicate direction of combined force of temporalis and masseter muscles.

Future studies with a larger sample size are required to obtain more convincing conclusions.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. The EMG values decreased in the resting state after TENS and tended to increase in the functional state.
2. The resting state EMG values of TA and MM before and after TENS showed a significant difference in a young population with normal occlusion.

PATIENT CONSENT

Informed patient consent has been obtained.

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Xingyu Wang: Methodology, Data Curation, Formal analysis, Writing - original draft, Writing - review editing. **Hao Liu:** Formal analysis, Software. **Xiangting Zhang:** Data Curation, Writing - original draft. **Zhe Qu:** Project administration. **Jiaming Zhao:** Conceptualization; Funding acquisition.

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