

**Quantitative Comparison
Between: Temporalis & masseter muscles
In: Women & Men denture wearers
By: Power Spectrum Analysis of EMG parameters.**

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Abstract:

This study accomplished by using the power spectrum analysis of EMG parameters registered by surface electrodes secured on major bulk center of anterior temporalis and masseter muscles of (12) women denture wearers and (16) men denture wearers with age range (48-58) years.

The results were obtained and statistically analyzed to compare the values of amplitude and frequency parameters obtained from each subject groups during clenching in maximum intercuspation position (MIP), right lateral position (RLP) and left lateral position (LLP) and, also, during chewing (3) grams of peanuts and (5) one cubic centimeter pieces of carrot.

The quantitative comparison showed that the men denture wearers registered higher amplitude values than women denture wearers , and that indicate the presence of large size motor units, in temporalis and masseter muscles of men subjects, which were responsible for the registration of the higher values by synchronization of motor unit action potentials. Whereas, the frequency parameters of the two subject groups showed no significant differences which means the number of the motor units and firing phases are almost the same.

These results can be utilized in treating any problem occur in masticatory muscles by: accomplishing the needed modifications in complete and partial denture design, the choice of artificial teeth and the manner of setting them according to the more convenient concept of occlusion of complete denture.

الخلاصة :

هذه الدراسة أقيمت لغرض مقارنة نشاط العضلة الصدغية والعضلة الماضغة ل (12) امرأة و (16) رجل من لابسسي طقم الأسنان الكامل وقد تراوحت أعمارهم بين (48-58) سنة. هذه المقارنة أجريت بواسطة تحليل طيف القوى للفحص الكهربائي الفسيولوجي لنشاط كل عضلة للحصول على معدلات السعة والتردد للوحدات الحركية العصبية أثناء خمسة فحوص هي :

1. الإطباق في وضع التشابك الأقصى (الإطباق المركزي).
2. الإطباق في الوضع الجانبي الأيمن.
3. الإطباق في الوضع الجانبي الأيسر.
4. مضغ ثلاث غرامات من حبات الفستق.
5. مضغ خمسة قطع بحجم (سنتيمتر مكعب) من الجزر.

وقد بينت هذه الدراسة ما يلي :

1. إن الرجال لابسسي طقم الأسنان الكامل سجلوا معدلات سعة أعلى مما سجلته النساء لابسسات طقم الأسنان الكامل وهذا يعني إن عضلات المضغ عند الرجال تمتلك وحدات حركية عصبية أكبر حجماً تعطي نتائج أعلى عند تزامنها في إطلاق المحفزات الكهربائية وتطابق وجوها مع بعضها.
2. أما معدلات التردد فلم توضح وجود فروق ذات أهمية عند المجموعتين المختبرتين وهذا يعني أن

عدد الوحدات الحركية العصبية في العضلات المفحوصة لكلا الجنسين هي متقارب بينهما وكذلك تتقارب بينهما أعداد المحفزات الكهربائية.

هذه النتائج بالإمكان الاستفادة منها لمعالجة المشاكل التي تحصل في عضلات المضغ لدى لابسى طقم الأسنان الكامل وحتى الطقم الجزئي وهذا من

خلال الإجراءات التالية:

1. تحويل تصميم طقم الأسنان الكامل أو الجزئي.
2. تغيير مواصفات الأسنان الصناعية.
3. تغيير نظم الأسنان الصناعية باختبار نظرية إطباق طقم الأسنان الكامل الملائمة لكل حالة.

Introduction:

Every dentist must have sufficient knowledge about the fundamental aspects of masticatory muscle activity. These muscles can be represented for activity evaluation by anterior temporalis and masseter muscles (1). The activity of anterior temporalis and masseter muscles were recorded using electromyography (EMG) with surface electrodes (2). The evidence on whether women and men denture wearers response differently to a sustained jaw clench is sparse(3,4). The denture wearers were asked to perform continuous chewing tasks, in addition to sustained clenching in different positions(5) to distinguish among different masticatory muscle activities in both women and men denture wearers(6).

Aim of the study:

The study aimed to evaluate quantitatively the different activities of anterior temporalis and masseter muscles in women and men denture wearers.

Materials and methods:

Twenty eight subjects admitted to EMG departments in Medical City and Al-Kadhumiah hospital : Twelve women denture wearers and sixteen men denture wearers were informed to perform the tasks. Age of the two subject groups range from 48-to-58 years and they were without history or symptoms of previous complain or any abnormality in the tempromandibular joints and masticatory muscles.

Each subject gave informed consent. A pilot study did not find significant differences between right and left sides, so data were obtained from the right muscles only (3). All the denture wearers had been wearing their complete dentures at least for three months with high degrees of satisfaction during clenching , chewing and speech (1).

Instrumentation:

DANTEC counter- point EMG system was used for all the electrophysiological analysis of sensory and motor neuron conduction parameters and muscle activities. Whereas, the grounding electrodes are (Velcro ribbon) strap surface grounding electrodes(DANTEC 13 S 93), which were used to protect the subject against electrical hazard and to reduce artifacts and the interference.

A pair of disposable bipolar surface recording electrodes (DANTEC 13 L 36) were used to pick up responses rom the muscles to be tested. For performing the chewing investigations peanuts and pieces of equal size of peeled raw carrot were selected(7).

Methods:

The subject seated in a chair without headrest in a prepared EMG room and instructed to straight his/ her back to produce a Frankfort plane parallel to the floor of the room(8).

The subject instructed to be completely relax and minimize any movement during the recording epochs. The grounding electrodes were soaked in normal saline and then scured to the right or left wrist of the subject(9).

The location of recording electrodes sites were determined before securing the electrodes as follow: Anterior temporalis, the major bulk center of it can be felt by palpating the area slightly above and behind the eyebrow of each side after asking the subject to clench on the posterior teeth. T he major bulk center of masseter muscle can be felt by palpating the area near the angle o the mandible after asking the subject to clench on the posterior teeth again, also this area can be determined by indicating the area at the mid-line between the lower border of xygomatic arch and the lower border of the mandibular body(10).

The skin surface at electrode sites thoroughly scrubbed using an alcohol soaked cotton pieces to reduce impedance between the skin and the electrodes (11).Enough amount of electrode gel squeezed over the surface of electrodes and scattered evenly to enhance electrical conduction from the skin surface. Then the recording electrodes secured on their determined sites with their poles parallel to the muscle fibers(11). The interdistance between the two poles of the recording electrodes was 1.5 cm. center-to-center(8).The machine was equipped by spectral analyzer which will give us the power spectral analyzing automatically from analysis of electrical activity of the last 50 m.sec. of a recording epoch within each muscle analyzed. From each epoch scan-averaged spectrum, the amplitude range, root mean square, mean rectified value, minimum frequency and 50%frequency parameters were taken in consideration.

Data acquisition:

EMG protocol included three epochs for the following test type recordings:

1. Clenching in maximum intercuspatation position(MIP).
2. Clenching in right lateral position(RLP).
3. Clenching in left lateral position(LLP).
4. Chewing the first test(peanut).
5. Chewing the second test food(carrot).

After every recording epoch a 30 sec. recovery period was allowed before starting another recording epoch to avoid muscle fatigue(12). The mean of the three accepted recordings for every test type was used for estimating the results. After adhering the electrode poles and setting the machine, to obtain the power spectrum analysis ,the subjects were instructed to place their dentures in maximum intercuspatation position and they were requested to bite "as hard as they can" during the records until instructed to stop(13). Then the subjects instructed to move their mandibles to the right sides and on a given command they exert maximum clenching until instructed to stop. The same procedure was repeated but bringing the mandible to the left sides.

For chewing tests the recording electrodes secured on the preferable side to the subjects or on the right side if they did not possess a preferable side(9), also, the subjects were instructed to put the test food between the upper and lower posterior artificial teeth of the dentures and start chewing (14). The subjects were given 3 gr. Of peanuts and 5 cubic cm. pieces of carrot for the first and second chewing tests respectively(7).

Statistical analysis:

Paired t-test was used to determine the significance levels of difference in women and men denture wearers.

Results:

1. EMG of anterior temporalis muscles activity in women and men denture wearers subjects were calculated as amplitude range(Amp.Rg), root mean square(RMS), mean rectified value(MRV), minimum frequency (Mn Frq) and median frequency(50%Fr).

The values were presented as(mean+/-S.D) during clenching investigations: maximum intercuspation position(MIP), right lateral position(RLP) and left lateral position(LLP), and chewing investigations: chewing 3 gr. Of peanuts and chewing 5 cubic cm. of carrot pieces. The results are as follow:

- a. During clenching in MIP: There is a highly significant increase in amplitude range, root mean square and mean rectified value parameters of the men subjects compared with the same parameters of the women subjects($P < 0.01$). While, in a minimum frequency and median frequency parameters showed non-significant differences between parameters of the two subject groups ($P > 0.05$), (Table.1).
 - b. During clenching in RLP: There was a highly significant increase in mean rectified value and median frequency parameters in men subjects than in women subjects ($P < 0.01$), while there was non-significant differences in other parameters ($P > 0.05$), (Table.2).
 - c. During clenching in LLP: There was highly significant increase in root mean square and mean rectified value parameters of the men subjects than in women subjects ($P < 0.001$), while other parameters showed non-significant differences ($P > 0.05$), (Table.3).
 - d. During chewing peanuts: There was a significant increase in root mean square and mean rectified value parameters of the men subjects than in women subjects ($P < 0.05-0.01$), while other parameters showed non-significant differences ($P > 0.05$), (Table.4).
 - e. During chewing carrot: Only the mean rectified value parameter showed significant increase of the men subjects than women subjects ($P < 0.05$). The amplitude range and the root mean square parameters showed slight increase in the men parameters but it is non-significant ($P > 0.05$), also minimum frequency and mean frequency parameters showed non-significant differences ($P > 0.05$), (Table.5).
2. EMG of masseter muscles activity in women and men subjects were calculated, also, as amplitude range(Amp.Rg), root mean square(RMS), mean rectified value(MRV), minimum frequency(Mn Frq), and median frequency(50% Fr).

The values were presented as (mean+/-S.D) during clenching investigations: maximum intercuspation position(MIP), right lateral position(RLP) and left lateral position(LLP), and chewing investigations: chewing 3 gr. Of peanuts and chewing 5 cubic cm. of carrot pieces. The results are as follow:

- a. During clenching in MIP: There were a significant increase in amplitude range($P < 0.05$), and a highly significant increase in minimum frequency and median frequency parameters of the women subjects than in men subjects($P < 0.01$). Other parameters showed non-significant differences($P < 0.05$), (Table.6).

- b. During clenching in RLP: Amplitude range and mean rectified value EMG parameters showed a significant increase in men subjects than in women subjects ($P < 0.05$), the root mean square parameter showed non-significant difference ($P > 0.05$), while the minimum frequency and median frequency showed highly significant increase in women than in men ($P < 0.01$) (Table.7).
- c. During clenching in LLP: All EMG parameters of the men subjects showed a highly significant increase than women subjects ($P < 0.001$) (Table.8).
- d. During chewing peanuts: Amplitude range ,root mean square and rectified mean value parameters were highly significant increased in men subjects than in women subjects ($P < 0.001$), but minimum frequency and median frequency parameters showed non-significant differences between the two tested subject groups ($P > 0.05$), (Table.9).
- e. During chewing carrot: There were a highly significant increase in amplitude range, root mean square and mean rectified value parameters in men subjects than in women subjects ($P < 0.001$), while the two frequency parameters showed non-significant differences between the tested subject groups ($P > 0.05$) (Table.10).

Discussion:

Knowledge about muscle activity in women and men denture wearers is very important to understand the muscle behavior of each group, also, it is of huge benefit to compare between them to find the effect of gender factor on muscle activity and to expect the problems which may arise due to hypoactive masticatory muscles. Finally, we can employ these information in improving complete denture efficiency according to the need of each gender.

Evaluation of EMG parameters depend on amplitude parameters which are: amplitude range, root mean square and mean rectified value, these parameters reflect the size of the motor units in each muscle, while the frequency parameters, which are: minimum frequency and median frequency, reflect the size and number of active motor units in each muscle.

Hence, we can depend on of the amplitude parameters and one of the frequency parameters to compare the masticatory activity of women and men denture wearers. It is well known that power spectrum analysis can produce more precise results, so it is a recommendable method that can better serve the desired aim of this research.

The result of power spectrum analysis of anterior temporalis and masseter muscles of the two tested subjects can be understood as following:

1. The obvious increase in amplitude values, of the two muscles in men subjects during clenching and chewing tasks, is indicating the increase in number of fibers atrophied which is the reason after decreasing the number of motor units in men muscles. Those motor units will synchronize to be larger in size and that give the interpretation for the increase in amplitude values in men muscles than in women (15, 16).
2. There is almost equal values in frequency parameters of anterior temporalis muscles of both subjects which is due to that anterior temporalis muscle compose of 30% type I (slow fatigue fibers) and 70% type II (fast fatigue fibers) (17), I.e. the dominant composition of the muscles of both subjects is fast fatigue fibers which are responsible for the appearance of the almost equal frequency parameters values in women and men denture wearers.
3. The noticed increase in frequency parameters values of masseter muscles, in women subjects during clenching tasks, is expected to be due to that during sustained clenching the masseter muscles of women denture wearers, more than men, activate larger number of motor unit action potentials to perform the same clenching tasks of the men subjects resulting in elevating the value of frequency parameters. This graduating energy came because of continuous training of complete denture wearers ,specially, most of the dentures were constructed according to balanced occlusion concept (18).

4. The non-significant frequency parameters value of masseter muscles, in both subjects during chewing tasks, is due to that masseter muscles of both subjects activate not all the motor units, they possess, but only the needed number of motor unit action potentials which almost the same in both subject groups.

These results are consistent with those of Stalberg et al.,1986(19) and came in contrast to suggestion of Lee et al.,1998(4).

Conclusion and suggestions:

1. The impression created by the results showed that power spectrum analysis of EMG parameters can be used for comparative quantitative studies of masticatory muscles in women and men denture wearers.
2. The amplitude parameters values are higher in men than in women denture wearers.
3. The frequency parameters values are not affected by gender variation.
4. Power spectrum analysis of EMG parameters can be used as one of the investigations, during examination and diagnosis stage, to aid in determining the preferred design, the suitable artificial teeth and the convenient concept of occlusion before starting any clinical or laboratory steps.
5. Amplitude parameters of EMG of masticatory muscles can be utilized for determining the coordinative efficiency of other masticatory muscles.
6. EMG studies of masticatory muscles in denture wearers received complete dentures constructed with different concepts of occlusion.

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Table.1: Means and standard deviations of EMG parameters of anterior temporalis muscles of 12-women and 16- men denture wearers during clenching in maximum intercuspation position.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.000	58.87126	202.2500	12	Women	Amplitude range
	211.29505	602.0000	16	Men	
0.000	6.68048	23.0833	12	Women	Root mean square
	22.54616	73.0625	16	Men	
0.000	5.23682	17.1667	12	Women	Mean rectified value
	16.40922	54.9375	16	Men	
0.803	27.92034	177.5000	12	Women	Minimum frequency
	32.24897	180.4375	16	Men	
0.672	34.56044	148.3333	12	Women	Median frequency
	29.26887	153.5000	16	Men	

(P. value is significant at >0.05)

Table.2: Means and standard deviations of EMG parameters of anterior temporalis muscles of 12-women and 16- men denture wearers during clenching in right lateral position.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.14	280.31361	365.5833	12	Women	Amplitude range
	354.37757	694.4375	16	Men	
0.111	29.38292	42.9167	12	Women	Root mean square
	173.71010	127.0000	16	Men	
	22.06653	32.7500	16	Men	
0.003	27.07767	64.0000	12	Women	Minimum frequency
	25.78392	150.9167	16	Men	
0.017	31.70482	179.5625	12	Women	Mean rectified value
0.003	21.35203	117.5000	12	Women	Median frequency
	29.92212	151.5000	16	Men	

(P. value is significant at<0.05)

Table.3: Means and standard deviations of EMG parameters of anterior temporalis muscles of 12-women and 16- men denture wearers during clenching in left lateral position.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
o.219	491.36819	337.8333	12	Women	Amplitude range
	261.25383	518.6875	16	Men	
0.000	6.11010	20.3333	12	Women	Root mean square
	26.09725	56.0000	16	Men	
0.000	4.52183	15.0833	12	Women	Mean rectified value
	20.13579	41.8750	16	Men	
0.657	40.75648	166.0000	12	Women	Minimum frequency
	27.01481	160.2500	16	Men	
0.820	47.78519	137.8333	12	Women	Median frequency
	21.69946	134.7500	16	Men	

(P. value is significant at<0.05)

Table.4: Means and standard deviations of EMG parameters of anterior temporalis muscles of 12-women and 16- men denture wearers during chewing 3-gr. of peanuts.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.080	188.84215	522.0833	12	Women	Amplitude range
	474.19054	786.5000	16	Men	
0.023	13.75406	42.0833	12	Women	Root mean square
	36.01984	68.6875	16	Men	
0.001	7.88939	23.6667	12	Women	Mean rectified value
	18.41727	45.5625	16	Men	
0.195	33.61942	136.9167	12	Women	Minimum frequency
	26.97128	152.1250	16	Men	
0.145	36.55092	108.1667	12	Women	Median frequency
	24.31452	125.4375	16	Men	

(P. value is significant at<0.05)

Table.5: Means and standard deviations of EMG parameters of anterior temporalis muscles of 12-women and 16- men denture wearers during chewing 5-cubic cm. pieces of carrot.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.059	222.80750	526.5000	12	Women	Amplitude range
	329.05987	744.5000	16	Men	
0.059	19.49359	64.0000	12	Women	Root mean square
	28.94564	65.1250	16	Men	
0.022	10.46495	25.3333	12	Women	Mean rectified value
	16.65220	38.6875	16	Men	
0.411	19.19971	137.4167	12	Women	Minimum frequency
	24.50298	144.5625	16	Men	
0.383	23.20707	110.7500	12	Women	Median frequency
	20.93552	118.1875	16	Men	

(P. value is significant at<0.05)

Table.6: Means and standard deviations of EMG parameters of masseter muscles of 12-women and 16- men denture wearers during clenching in maximum intercuspation position.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.019	74.97313	376.3333	12	Women	Amplitude range
	464.41526	716.0625	16	Men	
0.307	63.12518	61.3333	12	Women	Root mean square
	56.97563	87.1250	16	Men	
0.512	66.02548	51.5000	12	Women	Mean rectified value
	50.54355	66.1250	16	Men	
0.003	27.01290	175.6667	12	Women	Minimum frequency
	14.02245	149.6875	16	Men	
0.009	32.06657	160.4167	12	Women	Median frequency
	14.13683	135.1250	16	Men	

(P. value is significant at<0.05)

Table.7: Means and standard deviations of EMG parameters of masseter muscles of 12-women and 16- men denture wearers during clenching in right lateral position.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.030	85.19639	402.6667	12	Women	Amplitude range
	464.41526	716.0625	16	Men	
0.39	10.65861	45.1667	12	Women	Root mean square
	65.97563	87.1250	16	Men	
0.039	8.57056	34.0000	12	Women	Mean rectified value
	50.54355	66.1250	16	Men	
0,001	7.16684	166.5000	12	Women	Minimum frequency
	14.02245	149.6875	16	Men	
0.006	9.50080	140.4167	12	Women	Median frequency
	14.13683	135.1250	16	Men	

(P. value is significant at<0.05)

Table.8: Means and standard deviations of EMG parameters of masseter muscles of 12-women and 16- men denture wearers during clenching in left lateral position.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.000	93.58937	274.3333	12	Women	Amplitude range
	281.51231	826.1250	16	Men	
0.000	22.75096	40.8333	12	Women	Root mean square
	36.64964	97.4375	16	Men	
0.000	15.55050	31.0000	12	Women	Mean rectified value
	27.75601	72.5625	16	Men	
0.000	20.14248	146.9167	12	Women	Minimum frequency
	11.86873	179.7500	16	Men	
0.000	36.85187	115.6667	12	Women	Median frequency
	13.26760	165.1875	16	Men	

(P. value is significant at<0.05)

Table.9: Means and standard deviations of EMG parameters of masseter muscles of 12-women and 16- men denture wearers during chewing 3-gr, of peanuts.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.003	69.35395	453.8333	12	Women	Amplitude range
	1043.70178	1463.9375	16	Men	
0,001	8.23656	37.2500	12	Women	Root mean square
	82.76128	126.3125	16	Men	
0.000	6.76667	21.8333	12	Women	Mean rectified value
	41.34388	71.3750	16	Men	
0.584	24.77658	122.6667	12	Women	Minimum frequency
	53.20636	131.8750	16	Men	
0.863	29.56798	110.5833	12	Women	Median frequency
	51.47390	107.6875	16	Men	

(P. value is significant at<0.05)

Table.10: Means and standard deviations of EMG parameters of masseter muscles of 12-women and 16- men denture wearers during chewing 5- cubic cm. piece of carrot.

P. value	Std. deviation	Mean	Number	Gender of denture wearers	EMG parameters
0.001	82.49642	499.7500	12	Women	Amplitude range
	886.69592	1434.9375	16	Men	
0.000	4.33712	43.4167	12	Women	Root mean square
	77.82844	151.2500	16	Men	
0.000	4.96274	28.0833	12	Women	Mean rectified value
	46.20516	96.6250	16	Men	
0.231	33.53820	120.0833	12	Women	Minimum frequency
	31.68326	135.3125	16	Men	
0.180	37.45330	94.7500	12	Women	Median frequency
	36.63190	114.1875	16	Men	

(P. value is significant at<0,05)