

Electromyographic Changes in Thyrotoxicosis

Khalid I. Mussa, MRCP;

Summary:

Objectives: To document electromyographic changes in thyrotoxic patients, and to categorize the type of myopathic process in thyrotoxicosis.

Design: This case control study was designed to show the electromyographic changes in thyrotoxic patients and to compare these findings with that of normal aged matched controls to show the significance of these changes in thyrotoxic patients. Student's test was applied on the results and P value was extracted.

Subjects: Subjects in this study were chosen according to certain criteria depending mainly on their blood level of thyroid hormone (T3, and T4) and TSH. All of them are thyrotoxic patients, their ages range between 15 to 45 years. They were 25 patients (15 female and 10 males). Another 25 subjects were chosen as normal controls they were of the same age and sex, patient with features of myopathy or neuropathy from diseases other than thyrotoxicosis were excluded carefully from studied patients and the normal controls.

Results: EMG finding in thyrotoxic patients was as follows: No spontaneous activities in the proximal muscles (deltoid and in rectus femoris muscles). The amplitude of the motor unit action potentials was ranging between (200-800 microv) with a mean of (488.8 +/- 159.3microv.) in the deltoid muscle, while the amplitude of the action potential in rectus femoris muscle in thyrotoxic patients was ranging between (350-900 microv.). In abductor pollicis brevis muscle the action potential amplitude in thyrotoxic patients was ranging between (500-2150 microv.), there was significant difference between thyrotoxic patients and normal controls. The duration of the motor unit potential in thyrotoxic patients was ranging between (7—11.5 msec.) with a mean of (8.51 +/- 1.24 msec) in the deltoid muscle, slightly higher figures in rectus femoris muscle, this indicates significant difference in the duration of action potential between patients and normal controls. The other parameters of EMG study all indicate a myopathic process involving proximal muscles in 76% of thyrotoxic patients and a neuropathic process involving distal muscles in 28% of thyrotoxic patients.

Conclusions:

1-thyrotoxicosis involves proximal muscles more than distal muscles.

2-myopathic process in thyrotoxicosis can be observed clearly in EMG study of the proximal muscles.

3-EMG findings in thyrotoxic myopathy includes, short duration polyphasic potentials, with early recruitment full interference pattern.

4-Distal muscles in thyrotoxic patients may show EMG findings of a rather neuropathic process.

Key word: Electromyography, thyrotoxicosis, proximal myopathy.

J Fac Med Baghdad
Vol. 49, No. 1, 2007
 Received: April 2006
 Accepted: June 2006

Introduction:

Thyrotoxicosis is a common clinical syndrome consequent to excess circulating thyroid hormone, can be caused by a number of different disorders such as Grave's disease, toxic multinodular goiter or toxic thyroid adenoma, thyroiditis, Iodide-induced hyperthyroidism, factitious thyroiditis and thyrotoxicosis due to excess TSH^[1].

The complaint of weakness is common in thyrotoxicosis and it represent the presenting symptom in 5% of patients^[2], physical examination may reveal weakness or wasting in 60% to 80% of thyrotoxic patients^[3].

Muscle disorders observed in thyrotoxic patients are:

- Chronic thyrotoxic myopathy.
- Exophthalmic ophthalmoplegia.
- Myasthenia gravis with toxic goiter.
- Periodic paralysis with thyrotoxicosis.

Thyrotoxic myopathy is characterized by progressive weakness and wasting of skeletal muscles, occurring in conjunction with overt or covert thyrotoxicosis.

The myopathic process more commonly involves muscles of the pelvic girdle and thighs. The shoulder and hand muscles show the most conspicuous atrophy.

Adequate treatment of thyrotoxicosis results usually in full recovery regarding bulk and power of the skeletal muscles involved in a matter of 2-3 months^[4,5,6].

The frequency of Myasthenia gravis in thyrotoxic patients is (20-30) times that of the general population^[5].

* Collage of Medicine; Baghdad University

Electromyographic changes in thyrotoxicosis appear predominantly in the proximal muscles, even if no muscle weakness is demonstrated clinically. These abnormalities may be observed in 60-100% of the patients [7].

The most frequent changes are shortened mean potential duration and increased polyphasia. Even at reduced strength of contraction there is a full interference pattern [4,7].

Patients and methods

In this study a 25 Iraqi thyrotoxic patient and another 25-aged matched normal controls were chosen in order to study electromyographic changes in thyrotoxicosis and to compare the results to that of normal controls.

Thyrotoxic patients were included in this study according to their blood level of thyroid and TSH hormones:

1. T_4 range was (18.5-32)Mg/dl, mean (23.8 +/- 5.4) normal value (4.5-12.5 Mg).
2. T_3 range was (2.5-4.2) nmol/L, mean (3.2 +/- 0.7) normal value (0.8-1.8 nmol/L).
3. TSH range was (0.08-0.3 Mu/ml), mean (0.23 +/- 0.1). normal value (0.3-4.5 Mu/ml)

All patients and control were fully examined neurologically looking for features of muscular weakness. Laboratory investigations including Creatinin Phosphokinase (CPK), serum potassium, EEG and prostigmine tests were done as needed. The patients were screened for other medical disorders or family history that is related to the production of different muscular diseases.

Electromyography (EMG) was done in the morning and at room temperature 25-27 °C. Neuromatic 2000 M is the equipment used in this study with concentric needle electrodes. The muscles used for EMG sampling in most patients and control are the right abductor pollicis brevis, right deltoid and right quadriceps femoris. After disinfecting the skin overlying the muscle to be examined the needle electrode was inserted.

The following parameters were significantly looked for during EMG examination of these muscles:

1. Spontaneous activity or insertional activity when the muscles are relaxed.
2. Motor unit amplitude, duration, shape, and percentage of polyphasia, were recorded and studied while the patient performing weak contraction of the muscles examined by EMG.
3. Polyphasia more than 12% considered abnormal (twenty different motor unit potentials of each muscle were recorded).
4. The pattern of electrical activity during maximum contraction was studied (interference pattern). Statistical analysis was applied on the results using Student's t-test. P value <0.05 considered to be significant.

Results:

A-Spontaneous activity in relaxed muscles.

In thyrotoxic patients there were no spontaneous activities in the deltoid and in the rectus femoris muscle, only 3 out of 25 patients showed spontaneous activities in their relaxed abductor pollicis brevis muscle. No significant spontaneous activity had been detected in the control group.

B-Motor unit potentials at weak voluntary contraction:

1-The amplitude of motor unit potentials:

In thyrotoxic patients the amplitude of the motor unit action potentials was ranging between (200-800microv) with a mean of (488.8 +/- 159.3microv.) in the deltoid muscle in comparison to the normal controls in which it was ranging between (400-1300microv.) with a mean of (658 +/- 182.9 microv.) there was significance difference between the patients and the normal controls (P<0.002).

EMG examination of rectus femoris muscle showed that amplitude of the action potential in thyrotoxic patients was ranging between (350-900 microv.) with a mean of (578 +/- 158 micro.) while in the normal controls the amplitude was ranging from (500-1500 microv.) with a mean of (578 +/- 205.99 microv.), P value (P<0.005) show significant difference between the patients and the normal controls.

Examination of the abductor pollicis brevis muscle revealed that the action potential amplitude in thyrotoxic patients was ranging between (500-2150 microv.) with a mean of (820 +/- 410 microv.) while in the normal controls the amplitude was ranging between (320-1200 micro.) with a mean of (610.8 +/- 223.8microv.), there was significant difference between the patients and the normal controls (P<0.05).

2-The duration of the motor unit potential:

The duration of the motor unit potential in thyrotoxic patients was ranging between (7—11.5 msec.) with a mean of (8.51 +/- 1.24 msec) in the deltoid muscle. in the normal controls the duration was (9-11.3 msec) with a mean of (10.22 +/- 0.65 msec), the difference was significant (P<0.001).

The duration of the motor unit potential in the rectus femoris muscle was ranging between (7-14.5 msec.) with a mean of (9.96 +/- 2.03 msec) in thyrotoxic patients. In the normal controls the duration was ranging between (10-14.1 msec) with a mean duration of (12.36 +/- 1.137 msec.). There was significant difference between the patients and the normal controls (P<0.001).

The duration of the muscle action potential in the abductor pollicis brevis muscle was ranging between (8-12.8 msec.) with a mean of (9.86 +/- 1.11 msec.) in thyrotoxic patients. In the normal controls the range was between (8-10 msec.) with a mean of (8.78 +/- 0.56 msec). There was significant

difference between the patients and the normal controls ($P < 0.002$)

3-The shape of motor unit potential:

In normal subjects the shape of motor unit potential was mainly diphasic or triphasic, polyphasic potentials were very few, their percentage below 12% and the duration mostly within the normal range.

In thyrotoxic patients the shape of motor unit potentials was diphasic or triphasic, but the percentage of polyphasic potentials of short duration in proximal muscles was high.

In the deltoid muscle 72% of thyrotoxic patients showed polyphasic potentials of short duration (more than 12%) and ranging between (20-40%).

In rectus femoris muscle 60% of thyrotoxic patients had shown polyphasic potentials of short duration ranging between (20-50%).

In the abductor pollicis brevis muscle of thyrotoxic patients the shape of the motor unit potentials was mainly diphasic or triphasic, but only three patients showed polyphasic potentials more than 12% of long duration action potentials.

4-The interference pattern:

Thyrotoxic patients showed early full interference pattern in deltoid and rectus femoris muscles, while in abductor pollicis brevis muscle all patients showed normal interference pattern except two patients in whom decreased interference pattern in maximum voluntary contraction was observed. In normal subjects, normal interference pattern was observed.

5-Mean potential duration evaluation:

In order to evaluate the mean potentials duration which is affected by patients age, thyrotoxic patient were divided into three groups, first group their ages ranges between (15 to 25 years), the second group between (25 to 35 years) and the third group between (35 to 45 years).

In the deltoid muscle there was no abnormal potential duration in the control group. In thyrotoxic patients (7 patients from the first group, 7 patients from the second group, and 5 patients from the third group) showed abnormal short potential duration compatible with diagnosis of myopathy, this represent (76%) of the patients Table (1).

In rectus femoris muscle (8 patients from the first group, 2 patients from the second group, and 4 patients from the third group) showed abnormal short potential duration, this represent (56%) of the patients. While the control group did not show any abnormal potential duration.

In distal muscle sampling (the abductor pollicis brevis) there was no abnormal potential duration in the control group. While in thyrotoxic patients (no abnormal potential duration in first group, only 2

patients in the second group, and 5 patients in the third group) showed abnormal long potential duration resembling that of neuropathic pattern. These finding present in (28%) of the patients.

Table (1) Mean potential duration evaluation

Age (years) Distribution	Patient No.	Deltoid Control thyrotoxic	Rectus femoris Control thyrotoxic
15-25	10	0 7(70%)	0 8(80%)
25-35	9	0 (77.7%)	0 2(22.2%)
35-45	6	0 5(83%)	0 4(66.6%)
Total	25	0 19(76%)	0 14(56%)

Discussion:

Previous electrophysiological studies of the muscles in thyrotoxic patients had proved myopathic changes in the proximal muscles ranging between 60 and 100% . This study confirms such findings in thyrotoxic Iraqi patients since there is no previous study or report done proved such findings in our country.

EMG findings:

In normal subjects, all muscles sampled were silent during relaxation. In thyrotoxic patients spontaneous activity in the proximal muscles were also absent, but distal muscles (abductor pollicis brevis muscle) showed fibrillation potentials and/or positive sharp waves in 3 out of the 25 patients, possibly due to peripheral nerve damage. Mc Coma had reported such changes also in thyrotoxic patients^[9]. Other studies also proved such findings^[10,11,12].

In this study the mean amplitude of the motor unit potential of the proximal muscle (deltoid and rectus femoris) in thyrotoxic patients was significantly lower than that of the control group. Similar findings were reported by others^[2] this indicate loss of muscles fibers and reduce fiber density, these changes in favor of myopathic disorder^[7].

The mean duration of motor unit potential in the proximal muscles in thyrotoxic patient was significantly shorter if compared to the control group. This is also in agreement with others findings^[3,6,13]. This finding also suggests loss of muscle fibers and reduced fiber density as a result of a myopathic process^[8].

The evaluation of mean potential duration in thyrotoxic patients showed abnormal potential duration in the proximal muscles in up to 76% of the patients. Nearly similar findings were also reported by others^[7]. While abnormal long

potential duration in distal muscles present in up to 28% of the patients indicating a rather neuropathic process, such findings were also reported by others [14].

Polyphasic potentials were significantly reported in thyrotoxic patients (polyphasia more than 12%), but polyphasia in thyrotoxic patients usually accompanied by short duration potential not like that found in neuropathic disorders where polyphasia usually accompanied by long duration potentials indicating axonal or anterior horn cells degeneration. The same findings were reported by others [3]. These finding also suggest loss of some muscle fibers in the motor unit, which is in favor of myopathic process.

In normal subjects all muscles examined showed good interference pattern indicating normal strength of muscle contraction [7], while in thyrotoxic patients the proximal muscles showed early recruitment full interference pattern, nearly the same finding was reported by other workers [2]. Distal muscles in thyrotoxic patients showed normal interference pattern except in 2 cases were interference pattern was abnormally reduced most likely due to a neuropathic process such findings were also reported by Mc Coma et al [9].

Conclusions:

- 1-thyrotoxicosis affects proximal muscles more than distal muscles.
- 2-myopathic process in thyrotoxicosis can be observed clearly in EMG study of the proximal muscles.
- 3-EMG findings in thyrotoxic myopathy includes, short duration polyphasic potentials, with early recruitment full interference pattern.
- 4-Distal muscles in thyrotoxic patients may show EMG findings of a rather neuropathic process.

References:

- 1-Larsan PR; *The thyroid. In Wyngaardan JB, Smith LH Jr, Bennet JC; (eds): Cecil textbook of Medicine, WB Saunders Co. 1992, PP. 1315-1340.*
- 2-Sollar S.M., Czymy JJ, Heffner RR Jr: *Neurological complications of thyrotoxicosis. Arch. Of physical Medicine and Rehabilitations. 1988, 69,41-44.*
- 3-Ramsay ID.: *Muscle dysfunction in hyperthyroidism, Lancet, 1966, 2, 913-935.*
- 4-Walton JN (eds); *disorders of voluntary muscles. (4th eds.), Edinburg, Churchill Livingstone 1991.*
- 5-Adam's RD, Vector M: *Principles of Neurology, (seventh ed.) Mc Graw-Hill 2001 PP 1519-1521.*
- 6-Sanderson K.V. and Adey W.R. ; *Electromyographic and endocrine studies in chronic thyrotoxic myopathy. J. of Neuro. Neurosurg. and Psych. 1952;15:200-205.*
- 7-Ludin H.P.: *Electromyography in Practice, George Thieme Verlage Stugart, New York. 1980.*
- 8-Kugelberg E.: *Electromyography in Muscle Disorders. J. of Neuro. Neurosurg. and Psych. 1947; 10:122.*
- 9-McComma AJ, Sica REP, Mc Nabb AR, Goldberg WM, Upton ARM: *Evidence of Reversible Motoneuron Dysfunction in Thyrotoxicosis. J. of Neuro. Neurosurg. And Psych. 1974; 37: 548-558.*
- 10-Feible JH, Campa JF. : *Thyrotoxic Neuropathy. J. of Neuro. Neurosurg. And Psych. 1976; 39: 491-497.*

- 11-Sica REP, Mc Coma AJ, Upton ARM, Longmire D. : *Motor Unit Estimation in the Small Muscles of the Hand. J. of Neuro. Neurosurg. and Psych. 1974, 37, 55-67.*
- 12-Aminoff MJ. : *Electrodiagnosis in Clinical Neurology. Churchill Livingstone 1980, Chap. 6 and 7.*
- 13-Butchal f. : *Electrophysiological abnormalities in Metabolic Myopathies and Neuropathies. Acta Neurol. Scan. 1970 suppl. 43, 129.*
- 14-Ludin H.P. Spiess H., Koenig MP. : *Neuromuscular Dysfunction Associated with Thyrotoxicosis. Eur. Neurol. 1969, 2, 269-278.*